SELECTED WATER RESOURCES ABSTRACTS

VOLUME 2, NUMBER 14
JULY 15, 1969

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SELECTED
WATER RESOURCES ABSTRACTS

A Semimonthly Publication of the Water Resources Scientific Information Center,
Office of Water Resources Research, U.S. Department of the Interior

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As the Nation's principal conservation agency, the Department of the Interior has basic responsibilities for water, fish, wildlife, mineral, land, park, and recreational resources. Indian and Territorial affairs are other major concerns of America's "Department of Natural Resources."

The Department works to assure the wisest choice in managing all our resources so each will make its full contribution to a better United States--now and in the future.

FOREWORD

Selected Water Resources Abstracts, a semimonthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. The contents of these documents cover the water-related aspects of the life, physical, and social sciences as well as related engineering and legal aspects of the characteristics, conservation, control, use, or management of water. Each abstract includes a full bibliographical citation and a set of descriptors or identifers which are listed in the **Water Resources Thesaurus** (November 1966 edition). Each abstract entry is classified into ten fields and sixty groups similar to the water resources research categories established by the Committee on Water Resources Research of the Federal Council for Science and Technology.

Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources. WRSIC is not presently prepared to furnish loan or retention copies of the publications announced.

Selected Water Resources Abstracts is designed to serve the scientific and technical information needs of scientists, engineers, and managers as one of several planned services of the Water Resources Scientific Information Center (WRSIC). The Center was established by the Secretary of the Interior and has been designated by the Federal Council for Science and Technology to serve the water resources community by improving the communication of water-related research results. The Center is pursuing this objective by coordinating and supplementing the existing scientific and technical information activities associated with active research and investigation program in water resources.

To provide WRSIC with input, selected organizations with active water resources research programs are supported as "centers of competence" responsible for selecting, abstracting, and indexing from the current and earlier pertinent literature in specified subject areas. Centers, and their subject coverage, now in operation are:

- Ground and surface water hydrology at the Water Resources Division of the U.S. Geological Survey, U.S. Department of the Interior.
- Metropolitan water resources management at the Center for Urban Studies of the University of Chicago.
- Eastern United States water law at the College of Law of the University of Florida.
- Policy models of water resources systems at the Department of Water Resources Engineering of Cornell University.
- Water resources economics at the Water Resources Research Institute of Rutgers University.
- Design and construction of hydraulic structures; weather modification; and evaporation control at the Bureau of Reclamation, Denver, Colorado.
- Eutrophication at the Water Resources Center of the University of Wisconsin.
- Water resources of arid lands at the Office of Arid Lands Studies of the University of Arizona.

The input from these Centers, and from the 51 Water Resources Research Institutes administered under the Water Resources Research Act of 1964, as well as input from the grantees and contractors of the Office of Water Resources Research and other Federal water resources agencies with which the Center has agreements becomes the information base from which this journal is, and other information services will be, derived; these services include bibliographies, specialized indexes, literature searches, and state-of-the-art reviews.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
Office of Water Resources Research
U.S. Department of the Interior
Washington, D. C. 20240

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06 WATER RESOURCES PLANNING
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10 SCIENTIFIC AND TECHNICAL INFORMATION
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ABSTRACT SOURCES

SELECTED WATER RESOURCES ABSTRACTS

01. NATURE OF WATER

1B. Aqueous Solutions and Suspensions

UNIFIED VIEW OF DIFFUSION AND DISPERSION,
Illinois Univ., Urbana. Dept. of Civil Engineering.
Edward R. Holley.
ASCE Proc, J Hydraul Div, Vol 95, No HY2, Pap 6462, pp 621-631, Mar 1969. 11 p, 5 fig, 13 ref, append.

Descriptors: *Diffusion, *Dispersion, Tracers, Flow, Turbulent flow, Laminar flow, Steady flow, Unsteady flow, Convection, Mass transfer, Mixing, Momentum transfer.
Identifiers: *Diffusion-dispersion relations.

Diffusion and dispersion are basically convective transport mechanisms. The method chosen for representing the convection in a mass balance equation is the determining factor in deciding whether diffusion or dispersion must be included in the conservation equation for a given flow. This principle is illustrated for molecular diffusion, turbulent diffusion, and longitudinal dispersion. In a given flow, the relative importance of diffusion or dispersion in different transport problems depends on the steepness of the concentration gradient. It is proposed that the term 'diffusion' be reserved for transport that is associated primarily with time-averaged velocity fluctuations and that 'dispersion' be used for transport associated primarily with the spatial average of velocity variations. (Knapp-USGS)
W69-05619

02. WATER CYCLE

2A. General

SENSITIVITY ANALYSIS METHOD OF SYSTEM IDENTIFICATION AND ITS POTENTIAL IN HYDROLOGIC RESEARCH,
Environmental Dynamics, Inc., Los Angeles, Calif.; and Banaras Hindu Univ., Varanasi (India).
For primary bibliographic entry see Field 07C.
W69-05603

PRECIPITATION-RUNOFF RELATIONS FOR VERY SMALL SEMIARID RANGELAND WATERSHEDS,
Agricultural Research Service, Tucson, Ariz.
H. B. Osborn, and L. Lane.
Water Resources Res, Vol 5, No 2, pp 419-425, Apr 1969. 7 p, 4 fig, 5 tab, 6 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff forecasting, Streamflow forecasting, Hydrograph analysis, Regression analysis, Antecedent precipitation, Rainfall, Runoff, Routing, Small watersheds, Arid lands, Mathematical models, Hydrographs.
Identifiers: Rangeland watersheds.

Simple linear regression models for predicting total volume of runoff, peak rate of runoff, duration of runoff, and hydrograph lag-time were developed using 3 yr of data from 4 small (0.56 to 11.0 acres) watersheds. The models developed indicated that runoff volume was most strongly correlated to total precipitation; that peak rate of runoff was most strongly correlated to the maximum 15-minute depth of precipitation; that flow duration was most strongly correlated to watershed length; and that lag time was most strongly correlated to watershed area. These independent variables accounted for 70, 70, 50, and 30%, respectively, of the variance in the predicted variables. The exponential decay form of the antecedent precipitation equation accounted for 8% of the variation in runoff on watershed but was insignificant on the others. Analysis indicates that the data represent the high frequency events. It is possible that these models will not accurately predict the low frequency events. (Knapp-USGS)
W69-05605

LINEAR TIME-VARYING MODEL OF A RAINFALL-RUNOFF RELATION,
Pittsburgh Univ., Pa. Dept. of Civil Engineering.
Chao-Liu Chiu, and Ronald P. Bittler.
Res supported by OWRR, Dept of Interior. Water Resources Res, Vol 5, No 2, pp 426-437, Apr 1969. 12 p, 11 fig, 3 ref. Grant No 14-01-0001-1590. OWRR Project No C-1146.

Descriptors: *Rainfall-runoff relationships, *Mathematical models, Synthetic hydrology, Unit hydrographs, Hydrograph analysis, Small watersheds, Statistical methods, Statistical models, Hyetographs, Hydrographs, Runoff forecasting, Streamflow forecasting.
Identifiers: Time-variant hydrological systems.

The linear time-varying system model of the rainfall-runoff relation can be represented by a first-order, linear differential equation with time-varying coefficients that depend on 2 parameters. The model does not require the time-variance assumption necessary in the conventional unit hydrograph method. The long- and short-term trends for a hydrologic system to change with time can be considered and described with the technique developed. Analysis of historical data for the rainfall-runoff relation of a basin used for an experimental study indicates that the response of the basin to rainfall significantly changes with months during a year, although the yearly variation is not significant. The developed model and techniques used in the experimental study to describe and predict the rainfall-runoff relation have proved satisfactory. (Knapp-USGS)
W69-05608

DETERMINATION OF THE GROUND-WATER COMPONENT OF PEAK DISCHARGE FROM THE CHEMISTRY OF TOTAL RUNOFF,
Nova Scotia Dept. of Mines, Halifax.
For primary bibliographic entry see Field 02F.
W69-05628

INVESTIGATION OF SURFACE AND UNDERGROUND RUNOFF (RUSSIAN).
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.

Moscow, 'Nauka', 1967. 186 p, 13 pap, ref.

Descriptors: *Water resources development, *Water management (Applied), *Conservation, *Water balance, Water policy, Industrial water, Planning, Hydrologic cycle, Technical feasibility, River flow, Geomorphology, Saline water, Floods, Groundwater, Runoff.
Identifiers: *USSR, Monograph.

A necessity for rational utilization of water resources in the USSR and the International Hydrologic Congresses held in the USSR and abroad have served as an impetus for conducting several analytical and experimental investigations on the industrial water balance methods and distribution and conservation of water resources in the USSR. This volume, which is the result of this interest, contains articles on the physico-technical problems associated with water resources, stability of annual and seasonal runoff and drainage, changes introduced into a regime of underground water and its development to prevent the incursion of sea water, kinematic and morphologic elements of river flow, and analysis of snowmelt, rain, and flood discharges. (Gabriel-USGS)
W69-05659

PHYSICO-TECHNICAL PROBLEMS IN MANAGING WATER RESOURCES (RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
M. F. Skribnyy.
'Nauka', In 'Invest of Surface and Underground Runoff', Moscow,/Issledovaniye Poverkhnostnogo i Podzemnogo Stoka, pp 7-25, 1967. 18 p, 2 fig.

Descriptors: *Water resources, *Water management, *Water supply, *Water distribution, *Water demand, Water law, Hydrologic budget, Hydrologic data, Water structure, Water requirements, Groundwater, Water pollution, Water works, Forecasting.
Identifiers: USSR hydrology.

After briefly reviewing the problems discussed at the International Hydrologic and Meteorologic Congresses taking place from 1937 to 1965, the author discusses the USSR water supplies and water needs and indicates the importance of knowledge about physics of the hydrosphere. He believes that study of the hydrosphere should be used for solution of problems in the following areas: (1) relationship which exists between lithosphere, biosphere, and aerosphere; and (2) protection of man and the national economy from events associated with extremes in the water cycle. For convenience in studying the hydrologic parameters of the continents, the author subdivides segments of hydrology into the following topics: hydrology as a science; history of hydrology; hydronomy; paleohydrology; hydrography; hydrometry; water balance; aerohydrology; rain hydrology; snow research; glacier research; geohydrology; hydrology teaching; river water balance; low flow studies; river hydraulics; flood study; erosion and deposition study; hydrophysics of rivers; channel studies; coastal line study; river estuaries; hydrochemical processes; hydrobiological processes; limnology; reservoir hydrology; marshland study; forest hydrology; agricultural studies; and urban hydrology. (Gabriel-USGS)
W69-05660

MASS BALANCES OF SOME NORTH CASCADE GLACIERS AS DETERMINED BY HYDROLOGIC PARAMETERS: 1920-65,
Geological Survey, Tacoma, Wash.
For primary bibliographic entry see Field 02C.
W69-05664

SYNOPTIC TEMPERATURE MEASUREMENTS OF A GLACIER LAKE AND ITS ENVIRONMENT,
Geological Survey, Tacoma, Wash.
For primary bibliographic entry see Field 02C.
W69-05665

APPLICATION OF ELECTRONIC COMPUTERS TO IRRIGATION AND DRAINAGE SYSTEM PROBLEMS,
Bureau of Reclamation, Denver, Colo.
Francis E. Swain.
Pap, Symp Appl Comput Anal Various Probl Relating Irrig Drain Syst, Mexico City, Apr 1969. 32 p, 12 ref.

Descriptors: *Irrigation systems, Computer programming, Groundwater, *Drainage systems, Computer programs, Computers, Runoff forecasting, Hydrology, Flood routing, Sedimentation, Earthworks, Cross-sections, Land classification, Water conveyance, Irrigation, Drainage, Irrigation canals.
Identifiers: Cost savings, Problem solving.

Electronic computers are used to solve a wide variety of problems encountered in irrigation and drainage systems and in related fields. The most obvious reasons for using electronic computing equipment are: to reduce the time and cost required to carry out numerical calculations; to provide more data upon which more intelligent decisions can be based; and to free the engineer or scientist from the drudgery of routine manual computations. Studies of hydrologic, irrigation, and drainage systems have previously been conducted as separate analyses. All important aspects of such studies cannot be determined properly by this approach. For exam-

ple, simulation of ground-water systems on a digital computer and analysis of water quality requirements are intimately interconnected. To analyze water resource problems in an appropriate manner, the Bureau of Reclamation is attempting to integrate surface water systems, ground-water systems, and water quality control in project planning and operation studies. Such integrated analyses are possible only by using high-speed electronic computing equipment. Other problems of particular interest to irrigation and drainage specialists where computers can be used effectively are discussed. (USBR)
W69-05803

THE WESTERN WATER SUPPLY--WHERE IT IS,
Pacific Northwest River Basins Commission, Vancouver, Wash.
Charles W. Hodde.
Pap, League Women Voters Educ Fund Conf, Salt Lake City, Utah, Feb 1969. 15 p, 10 fig, 3 tab.

Descriptors: *Rainfall, Runoff, Reservoir storage, Streamflow, *Water supply, Water storage, Underground water storage, Groundwater, Glaciers, Groundwater mining, Groundwater recharge, Annual, *Water, Atmospheric precipitation, Colorado River Basin, Columbia River Basin, California, Great Basin, Oregon, Washington.
Identifiers: *Rainfall expectancy, *Water supply forecasting, Seasonal variations, Groundwater sources, *Western United States.

The water supply in the Western United States consists of present rainfall, accumulated rainfall, and reasonably safe predicted rainfall. Factors relative to water supply are discussed for the area west of the Mississippi River, paying particular attention to the Columbia-North Pacific Region, the Upper and Lower Colorado River Basins, the Great Basin Region of Utah and Nevada, and the California Region. The first consideration is that average or long-range mean annual rainfall or runoff (referred to as streamflow) is not always usable supply. Second, when discussing water in terms of quantity and distribution, more money problems associated with solutions exist than water problems. The third factor concerns dependable predictable future rainfall. (USBR)
W69-05807

A NONLINEAR HYDROLOGIC SYSTEM RESPONSE MODEL,
Illinois Univ., Urbana.
Ramanand Prasad.
Proc, Amer Soc Civil Eng, Vol 93, No HY4, pp 201-221, July 1967. 21 p, 9 fig, 2 tab, 15 ref, 2 append.

Descriptors: *Simulation analysis, *Analog computers, *Hydrologic equation, *River basins, Mathematical models, Numerical analysis, Rainfall-runoff relationship, Reservoirs, Storm runoff.
Identifiers: Illinois, Nonlinear differential equations.

The effects of the physical factors responsible for the transformation of rainfall excess into direct runoff were simulated by the action of a conceptual nonlinear reservoir. A nonlinear differential equation of the basin response was derived. Because no analytical solution for the system response equation existed, solutions were found by means of an electronic analog computer and a numerical method. Model parameters were found to be correlated with basin, main channel, and rainfall characteristics for seven east central Illinois basins. The consistency of the results obtained from an analysis of storms over those basins indicated that the proposed model could be adopted for nonlinear simulation of the hydrologic system response. (Gysi-Cornell)
W69-05858

THE INFILTRATION COMPONENT OF A PASTORAL EXPERIMENTAL CATCHMENT, PARTS 1 AND 2,
Soil Conservation Authority, Kew (Australia).
For primary bibliographic entry see Field 02G.
W69-05901

THE EVAPOTRANSPIRATION COMPONENT OF A PASTORAL EXPERIMENTAL CATCHMENT,
Soil Conservation Authority, Kew (Australia).
For primary bibliographic entry see Field 02D.
W69-05902

CLIMATIC ATLAS OF THE UNITED STATES,
Environmental Science Services Administration, Washington, D. C.
For primary bibliographic entry see Field 02B.
W69-05922

CALCULATION OF MAXIMUM WATER DISCHARGES ORIGINATING FROM RAIN AND SNOW (IN RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
For primary bibliographic entry see Field 02E.
W69-05943

2B. Precipitation

DETERMINING MAXIMUM RELIABILITY AND EFFICIENCY OF HYDROMETEOROLOGICAL SYSTEMS AND INSTRUMENTS,
State Hydrological Inst., Leningrad (USSR).
For primary bibliographic entry see Field 07A.
W69-05658

REGIONAL RAIN MODELS WITH SPACE-AND TIME-CORRELATED STRUCTURE,
Matson Research Corp., San Francisco, Calif.
Eric E. Sorensen.
Manage Sci, Vol 14, No 3, pp 239-249, Nov 1967. 11 p, 6 fig.

Descriptors: *Simulation analysis, *Rainfall simulators, *Regional analysis, Correlation analysis, Rainfall disposition, Spatial distribution, Time of concentration, Irrigation, Harvesting, Isohyets.

A generalized model was constructed which would simulate rainfall over regions containing gradient extremes of annual rainfall of 5 inches to 50 inches within the region for any given year. The specific application presented covered a region 5 miles by 14 miles. The model generated daily rain patterns of a spatial and temporal sequence correlated from over a large number of subareas within the region. Daily isohyets were constructed from simulated computer periods of an unlimited time horizon. It was concluded that the model could interact with irrigation or harvesting models in order to analyze the sensitivity of those models to rainfall incidence, severity and duration. (Gysi-Cornell)
W69-05731

THE LEGAL IMPLICATIONS OF ATMOSPHERIC WATER RESOURCES DEVELOPMENT AND MANAGEMENT.
Arizona Univ., Tucson. Weather Modification Law Project Staff.

Final Report for Bureau of Reclamation, Office of Atmospheric Water Resources, October, 1968. 248 p, 1 append. 14-06-D-6224.

Descriptors: *Weather modification, *Cloud seeding, *Legal aspects, Agreements, Claims, Contracts, Damages, International compacts, Interstate compacts, *Liabilities, Leases, Riparian rights, *Torts, Water laws, *Water rights, Water resources, Land ownership, Public land, Real property, *Resource development, Water management, *Governments, Coordination.

This report is an analysis of the legal implications of atmospheric water resources development and management. The arguments of landowners and of weather modifiers and their clients for private rights in water resources of the atmosphere are set forth. There is an examination of the legal theories and factual situations upon which legal liability might be based for precipitation management activities and their consequences. Defenses to such liabilities and employment of insurance and indemnification agreements to obtain relief from financial losses are explored. The legal problems in local development of additional yield from atmospheric sources are set forth, and state licensing, reporting, and other regulatory activities are analyzed. Different methods of interstate allocation of water are measured against the need to allocate among the states the rivers in the sky. There is a study of federal management and development of atmospheric water resources. International implications of weather modification are also treated. The report concludes with recommendations for further acquisition of factual information about weather modification, adjustments in state laws, and enactment of federal legislation to ensure sound development of our atmospheric water resources.
W69-05756

CLIMATIC ATLAS OF THE UNITED STATES,
Environmental Science Services Administration, Washington, D. C.
John L. Baldwin.
Environ Sci Serv Admin Atlas, June 1968. 80 p, 271 map, 15 tab.

Descriptors: *Climatic data, *Data collections, *United States, Meterological data, Weather data, Maps, Temperature, Precipitation (Atmospheric), Winds, Atmospheric pressure, Humidity, Dew point, Cloud cover, Solar radiation, Evaporation.
Identifiers: *Climatic atlas.

Climatic data for the U.S. are presented in an atlas of 40 sheets containing 271 climatic maps and 15 tables. The maps present in uniform format a series of analyses showing the national distribution of mean, normal, or extreme values of temperature, precipitation, wind, barometric pressure, relative humidity, dewpoint, sunshine, sky cover, heating degree days, solar radiation, and evaporation. (Knapp-USGS)
W69-05922

A COUNTRY-WIDE STUDY OF INTENSE RAINFALL FOR THE UNITED KINGDOM,
Hydrological Research Unit, Wallingford (England).
John C. Rodda.
J Hydrol, Vol 5, No 1, pp 58-69, Mar 1967. 12 p, 9 fig, 1 tab, 9 ref.

Descriptors: *Rainfall intensity, *Probable maximum precipitation, *Depth-area-duration analysis, Meteorology, Rain, Precipitation (Atmospheric), Precipitation intensity.
Identifiers: *United Kingdom.

Rainfall station data in the United Kingdom are analyzed to estimate the magnitude, frequency and duration of daily rainfall. The calculated daily rainfall magnitudes are shown by maps. A method is given for using average annual rainfall to calculate the one-day fall for a given return period. (Knapp-USGS)
W69-05925

AN INVESTIGATION OF METEOROLOGICAL CONDITIONS DURING A CALIFORNIA RAINFALL PERIOD,
California Univ., Los Angeles. Dept. of Meteorology.
T. N. Krishnamurti, and Bobby J. Higgins.
Calif Univ Water Resources Center Contrib No 119, Jan 1967. 96 p, 21 fig, 3 tab, 30 ref, 2 append.

Descriptors: *Rainfall, *Atmospheric physics, *California, Weather patterns, Winds, Air masses, Atmospheric pressure, Fronts (Atmospheric), Climatology, Meteorology, Weather forecasting, Remote sensing, Synoptic analysis, Topography.
Identifiers: Hovmoller impulses, Atmospheric pressure waves, Atmospheric pressure troughs, Wave impulses (Atmospheric).

Extended periods of California rainfall are generally associated with a long wave upper trough off the California coast. The trough is either slowly moving or stationary with several short wave impulses traveling through it from west to east. A Hovmoller impulse is a phenomenon frequently seen during the amplification of several long wave troughs and ridges with a speed approximately that of a group velocity in a non-divergent atmosphere. Large correlations of vorticity and mid-tropospheric divergence are found in the region of upper troughs and ridges and are important dynamic parameters in the maintenance of the Hovmoller impulse. The phase speed and group velocity of tropospheric long waves are examined empirically and theoretically. Actual wave movements are shown to compare closely to those in a barotropic, non-divergent atmosphere. A high correlation between mid-tropospheric convergence and absolute vorticity, during passage of a group-velocity impulse through a trough, suggests the impulse is maintained largely through vorticity production-destruction. The modifying effect of mountain barriers and blocking systems upon the group-velocity impulse is discussed. Zonal harmonic analysis and wave theory are combined to show that the group-velocity phenomenon seen in Hovmoller diagrams can be explained as an interaction between abnormally progressive ultra-long waves and normally progressive long waves. Separation of wave numbers from normal 500 mb charts suggests an organized behavior of ultra-long waves. It is suggested that the Hovmoller diagram can be used effectively as a tool for daily and long-range forecasting.
W69-05933

ACCURACY IN DETERMINING THE MEAN PRECIPITATION DEPTH OVER AN AREA,
Main Geophysical Observatory, Leningrad (USSR).
M. V. Gushchina, R. L. Kagan, and A. I. Polishchuk.
Trans from Trudy GGO, No 208, 1967, pp 49-63. Soviet Hydrol, Selec Pap, No 6, pp 585-596, 1967. 12 p, 2 fig, 5 tab, 6 ref.

Descriptors: *Network design, *Precipitation (Atmospheric), Statistical methods, Data collections, Rain gages, Rainfall.
Identifiers: *USSR, Mean areal precipitation.

The distributions of precipitation over large areas with variable physiography are studied statistically. Data on statistical structure are used in estimating the error in extrapolating areal precipitation on the basis of individual station data. Warm season (May-September) data from the Central Provinces, the Valdai Hills, and Primor'ye, USSR, were used. Totals were calculated for each for the hours 1900-0700 and 0700-1900, for 24 hr, 10 days, 1 month, and the period May-September. Mean square errors were determined and tabulated for 1,2,5,10,20,50, and 100 gaging stations covering areas of 1,10,50,100,500,1000,2000, and 5000 sq km. In most cases the accuracy of interpolating data between stations is considerably less than the accuracy of the areal mean. To make the interpolation accuracy equal to the accuracy at the mean, the number of stations must be increased. Lack of uniformity in the distribution of stations can result in large errors, and a weighted mean method must be used. (Knapp-USGS)
W69-05948

THE ECONOMIC APPROACH TO THE PLANNING OF A NETWORK OF METEOROLOGICAL STATIONS,
Main Geophysical Observatory, Leningrad (USSR).
For primary bibliographic entry see Field 07A.
W69-05949

2C. Snow, Ice, and Frost

MASS BALANCES OF SOME NORTH CASCADE GLACIERS AS DETERMINED BY HYDROLOGIC PARAMETERS: 1920-65,
Geological Survey, Tacoma, Wash.
Wendell V. Tangborn.
Int Ass Sci Hydrol Pub No 79, Gen Assembly of Bern, Sept-Oct 1967, pp 267-274, 1967. 8 p, 4 fig, 10 ref.

Descriptors: *Hydrologic budget, *Glaciers, Alpine, Climatology, Ablation, Melting, Weather, Precipitation (Atmospheric), Temperature, Snow, Firn, Evaporation, Runoff, Storage, Statistical methods, Mathematical models, Washington.
Identifiers: *North Cascades (Wash).

Ice and snow storage changes in the glaciers of the Thunder Creek drainage basin for the period 1920-65 were calculated by using hydrologic and meteorologic data from low elevation stations. The basis for these computations was the difference between streamflow in glacierized and non-glacierized drainage basins, combined with precipitation data from nearby valley stations. A significant correlation was found between balances measured for South Cascade Glacier (14 km south of the Thunder Creek basin) and balances calculated for Thunder Creek glaciers for the period 1958-65. The balance history of South Cascade Glacier for the period 1928-57 was estimated on the basis of this statistical relationship. The balance trend for the higher altitude Thunder Creek glaciers shows a major change occurring about 1944, from generally negative balances between 1920-44 to a gain in glacier mass between 1945-65. The balance trend for the lower elevation South Cascade Glacier shows a consistent loss of mass at the rate of 1.7 m of water per yr for the period 1928-44, and a loss rate of 0.6 m per yr for the period 1945-65. As a check on these long-term estimated balances, the total mass changes of South Cascade Glacier and of the North and South Klawatti Glaciers in the Thunder Creek basin were calculated on the basis of detailed topographic maps and aerial photographs. The results show close agreement between these independent calculations. (Knapp-USGS)
W69-05664

SYNOPTIC TEMPERATURE MEASUREMENTS OF A GLACIER LAKE AND ITS ENVIRONMENT,
Geological Survey, Tacoma, Wash.
William J. Campbell.
Commission of Snow and Ice, Proc Gen Assembly of Bern (Sept-Oct 1967), Int Ass Sci Hydrol, Pub No 79, pp 450-458, 1967. 9 p, 4 fig, 1 tab, 6 ref.

Descriptors: *Water temperature, *Lakes, *Glaciation, Thermal properties, Heat budget, Solar radiation, Remote sensing, Infrared radiation, Thermometers, Meteorology, Winds, Air temperature.
Identifiers: Lake water temperatures, Glacial lakes, Radiometry, Cold skin phenomenon (Lake water).

Temperature measurements of a 20 ha, 1,620 m high lake located at the terminus of South Cascade Glacier, Washington, and its ice and rock environment were made with infrared radiometers (8-14 micron range) during various meteorologic regimes. By making simultaneous measurements of lake surface temperatures with 4 sensors it was found that the 'cold skin' effect occurs, that is the radiometric temperature is cooler than that measured at the surface. The meteorological situation most favorable to the development of the 'cold skin' is a strong, dry drainage wind with clear skies. Temperature distributions of the lake surface and its background were mapped by remote infrared sensing from adjacent ridges. By correcting for reflectivity and emissivity changes, accurate synoptic maps of the lake surface temperature were obtained. It was found that the shallow, stable surface layer adjusts rapidly to changes in the drainage and valley winds. Several surface temperatures maps obtained during periods of strong drainage winds compare well with an infrared image obtained from an aircraft, showing a warm sector at the lake exit separated by a temperature front of high gradient from a cool sector having gradually cooler temperatures towards the glacier terminus. At times of no wind the surface temperature was uniform except for a narrow mixing zone at the glacier terminus. The warm sector was transported to the glacier terminus end of the lake by valley winds and a high gradient temperature front formed between it and the terminus mixing zone. (Knapp-USGS)
W69-05665

SEA-ICE DYNAMICS,
Geological Survey, Tacoma, Wash.
William J. Campbell.
Office Nav Res Rep 'Arctic Drifting Station,' pp 189-196, 1968. 8 p, 3 fig, 1 tab, 12 ref.

Descriptors: *Sea ice, *Drifting (Aquatic), *Ocean currents, Arctic Ocean, Flow, Water circulation, Icebergs, Coriolis force, Wind pressure, Winds, Model studies.
Identifiers: *Sea-ice dynamics, Ice pack drift.

Mathematical models of the motion of drifting sea ice are reviewed. Drift trajectories are the result of the interplay of forces of imperfectly understood nature. Theoretical models are so complex that the most recent can be solved only with the aid of high-speed computers. The models reviewed consider varying degrees of the effects of wind stress, water stress, coriolis force, internal ice stress, gradient currents, and boundary layers. The more recent models attempt to solve ice motion in terms of a fluid ice pack rather than a collection of independently-moving floes. Instruments and technology exist for determining the exact rheological properties of ice packs. Navigation techniques now permit fixes several orders of magnitude more accurate than past techniques. Satellite fixes permit the simultaneous, continuous, accurate position recording of several stations. Shorter-scale measurements may be made rapidly and accurately by laser and tellurometer surveys. In the present state of technology, more is to be gained by measuring several stations drifting together for a year than one drifting several years. (Knapp-USGS)
W69-05921

RELATIONSHIP OF AIR TEMPERATURE TO THE OCCURRENCE OF FRAZIL ICE AND ICE FLOW IN RIVERS,
Walenty Jarocki.
Warsaw, Cent Inst for Sci, Tech and Econ Inform, Transl of 'The action of frost on concrete hydraulic structures', Polish Pap no 29, 1966, Intro and Chapters 2, 3, and 4. 75 p, 4 fig, 13 tab, 53 ref, 10 append. Order from the Clearinghouse as TT-66-57040, Paper copy $3.00.

Descriptors: *Frazil ice, *Icebergs, *River flow, *Air temperature, Freezing, Ice-water interfaces, Velocity, Winds, Heat exchange, Soil physical properties, Thawing, Mathematical studies, Frequency, Probability, Channel morphology.
Identifiers: *Poland, Freezing phenomenon, Vistula river, Poprad river.

On the basis of earlier publications and using the Goncharova formula, the freezing of Polish rivers was investigated by utilizing the river cross section versus temperature and other pertinent data recorded for the Vistula, Poprad, and Skawa rivers. This investigation, however, is a part of a broader study for the evaluation of the effects of ice and freezing on the basic properties of hydraulic struc-

tures made of concrete and under the action of the Polish climate. The study shows that (1) frazil ice appears after a period of negative air temperatures; (2) the air temperature at which frazil ice appears is not constant but is dependent on the temperatures occurring during the period preceeding the appearance of the frazil ice, on the occurrence of wind, snow, water velocity, etc.; (3) in Poland, frazil ice is most frequently formed at air temperatures of -4 deg C; (4) the number of days with negative temperature during the period preceeding the appearance of frazil ice is not always the same; (5) the ice cover is in general formed after a lapse of some time from the appearance of frazil ice in the rivers; (6) the air temperature at which ice cover is formed may be higher, lower, or the same as the temperature at which frazil ice appears; (7) ice cover is generally formed at -8 deg C; (8) frazil ice or ice cover may not appear in spite of prevailing negative air temperatures; and (9) positive air temperatures of short periods may cause no thawing of rivers or drifting of ice after the ice cover is formed. (Gabriel-USGS)
W69-05923

CALCULATIONS OF SLIP OF NISQUALLY GLACIER ON ITS BED: NO SIMPLE RELATION OF SLIDING VELOCITY TO SHEAR STRESS,
Geological Survey, Tacoma, Wash.
Mark F. Meier.
Commission of Snow and Ice, Proc Gen Ass of Bern, Sept-Oct 1967, Int Ass Sci Hydrol, Pub No 79, pp 49-57, 1967. 9 p, 5 fig, 7 ref.

Descriptors: *Glaciers, *Movement, *Rheology, Mathematical models, Ice, Non-newtonian flow, Mechanical properties, Plasticity, Viscosity, Shear stress, Shear strength, Shear drag, Slopes.
Identifiers: *Nisqually Glacier (Wash), Glacial movement.

Measurements on Nisqually Glacier, Mount Rainier National Park, Washington, at a fixed geographic location, give 22 yearly values of surface velocity, surface slope, and changes in ice thickness. During this period (1943-66), surface velocity, slope and thickness varied continuously by large amounts. The data were used to calculate values of shear stress and slip on the bed by standard methods, making correction for the gradient in longitudinal normal stress. Slip on the bed was found not to be a simple single-valued function of shear stress. This implies that the velocity distribution within a valley glacier cannot be calculated by the standard methods, or that none of the existing theories of glacier sliding which relate sliding velocity to shear stress are valued. (USGS)
W69-05924

A COMPARISON OF MEASURED AND THEORETICAL SNOWPACK TEMPERATURES,
British Columbia Univ., Vancouver. Dept. of Civil Engineering.
M. C. Quick.
J Hydrol, Vol 5, No 1, pp 1-20, Mar 1967. 20 p, 8 fig, 5 ref.

Descriptors: *Snowpacks, *Temperature, *Mathematical models, Air temperature, Heat budget, Heat flow, Heat transfer, Melting, Conduction, Diffusion, Thermal conductivity.
Identifiers: Snowpack temperature profiles, Air temperature fluctuations.

Comparison of snowpack temperature measurements with a theoretical snowpack temperature model, showed that the model predicts both the damping and the increasing phase lag of surficially imposed temperature variations with depth in the snowpack. At least 150 hr is required for the snowpack to reach 85% of the air temperature at a depth of 1 ft. Analysis of the effect of a sinusoidal variation of air temperature shows increasing phase lag with depth. Both an increased rate of wave-form decay and a reduced rate of propagation of the temperature wave are shown when the snowpack is non-homogeneous. Daily temperature variations penetrate only about 1 ft into loose dry powder snow. The long term mean temperature variation penetrates to about 4 ft, where the temperature was a constant 32 deg F. The model studied was a snowpack at below-freezing temperatures. Extension of the model to melting snowpacks requires that the assumption of equality of air and snow temperature be dropped. The surface temperature of a melting snowpack is always 32 deg F. Surface heat transfer involves phase change from snow to water. The snowpack density and conductivity will modify with the amount of water saturation as melting progresses. (Knapp-USGS)
W69-05929

2D. Evaporation and Transpiration

ANALYSIS OF AN EVAPORATION CONTROL SYSTEM ON THE SEA OF GALILEE,
Arizona State Univ, Tempe.
For primary bibliographic entry see Field 03F.
W69-05601

EFFECT OF SMALL SURFACE WAVES ON EVAPORATION THROUGH MONOLAYERS,
Maryland Univ., College Park.
G. F. Dick Jr., and J. M. Marchello.
Res supported by Dept of Health, Education, and Welfare under Public Health Serv Grant. Water Resources Res, Vol 5, No 2, pp 395-400, Apr 1969. 6 p, 2 fig, 1 tab, 10 ref. Grant No 00323.

Descriptors: *Evaporation control, *Monomolecular films, Hexadecanol, Water conservation, Waves (Water), Model studies, Hydraulic models, Winds.
Identifiers: Capillary waves.

The role played by capillary-gravity waves on evaporation through monolayers was studied for waves in the 400 to 800 cpm range. Waves were generated in a small ripple tank during steady-state evaporation. Concentrations of n-hexadecanol ranging from 0 to 2.656 billionths of a mole per sq cm were studied. The waves destroyed much of the evaporation-retarding properties of the film. (Knapp-USGS)
W69-05604

RELATION OF WATER LOSS TO MOISTURE CONTENT OF HYDROPHYTES IN A NATURAL POND,
Geological Survey, Denver, Colo.
W. S. Eisenlohr, Jr.
Water Resources Res, Vol 5, No 2, pp 527-530, Apr 1969. 4 p, 2 fig, 3 ref.

Descriptors: *Water loss, *Evaporation, *Evapotranspiration, *Phreatophytes, Vegetation, Potholes, Ponds, Mass transfer, Energy budget, Moisture content.
Identifiers: Coteau du Missouri (ND), Hydrophytes, Prairie potholes.

Hydrophytes growing in natural ponds on the Coteau du Missouri in North Dakota have been studied. Previous studies in the same region showed how transpiration by hydrophytes could be separated from the total water loss from a natural pond, during the period that vegetation was growing in height, on the basis of a correlation between the height of vegetation and a mass-transfer coefficient. It is shown that a similar separation can be made during the period of declining activity of the vegetation. A significant correlation was found between the ratio of moisture content of vegetation to its oven-dry weight and the mass-transfer coefficient. Weekly photographs on Ektachrome Infrared Aero film helped to confirm some of the phenomena observed. (Knapp-USGS)
W69-05622

CONTROLLING TRANSPIRATION IN ASPEN WITH PHENYLMERCURIC ACETATE,
Utah State Univ., Logan.
For primary bibliographic entry see Field 03F.
W69-05627

AERODYNAMIC AND SURFACE FACTORS IN EVAPORATION,
Rothamsted Experimental Station, Harpenden (England); and Munich Univ. (West Germany). Meteorologisches Institut.
For primary bibliographic entry see Field 02I.
W69-05631

SIMULATION OF EVAPORATION FROM CONSTANT SOURCE WITH FINITE AREAS,
California Univ., Los Angeles.
For primary bibliographic entry see Field 07C.
W69-05636

STUDIES WITH ANTITRANSPIRANTS ON GRAPEVINES (VITIS VINIFERA VAR. SULTANA),
Commonwealth Scientific and Industrial Research Organization, Glen Osmond (Australia). Div. of Horticultural Research; and Commonwealth Scientific and Industrial Research Organization, Merbein (Victoria). Div. of Horticultural Research.
J. V. Possingham, G. H. Kerridge, and D. E. Bottrill.
Aust J Agric Res, Vol 20, No 1, pp 57-64, Jan 1969. 5 fig, 4 tab, 5 ref.

Descriptors: *Transpiration control, *Retardants, *Consumptive use, *Leaves, *Films, Inhibitors, Spraying, Rates of application, Root systems, Photosynthesis, Vine crops, Plant physiology.
Identifiers: *Antitranspirants, *Grapevines, *Acropol, *Polycote, Australia, Plastic films, Dry matter.

Selected transpiration suppressants were tested under glasshouse conditions for their effectiveness in reducing the water consumption of grapevines. The substances tested included three that form plastic films, Polycote J (Tag), Polycote S720, and Acropol (S789, a silicone type compound), and the inhibitor phenyl mercuric acetate. Acropol reduced water consumption by an average of 50% when applied as a leaf spray and was the only substance found to be an effective transpiration suppressant. Repeated applications at 12-day intervals were necessary and the substance had a morphogenetic effect, causing a significant increase in leaf area but a decrease in dry matter production, especially evident in the lower root weight of treated plants. The rate of sugar accumulation in grapes was not affected by Acropol when it was applied to plants in the field. (Affleck-Ariz)
W69-05675

USE OF ATMOMETERS IN ESTIMATING EVAPOTRANSPIRATION,
California State Dept. of Water Resources, Bakersfield.
John W. Shannon.
Irrig and Drain Speciality Conf, Las Vegas, Nevada, Nov 2-4, 1966, pp 109-130, 6 fig, 3 tab.

Descriptors: *Evaporation, *Evapotranspiration, *Atmometers, *Evaporation pans, Consumptive use, Instrumentation, Climatic data, Water requirements, Data collections, Energy, Water loss, Monthly, Estimating.
Identifiers: Evaporation demand, Crop coefficient.

The California Department of Water Resources has collected extensive records of evaporation from Livingston Black and White Atmometers. Several separate studies have been made to determine the effect of various operational and environmental factors upon atmometer evaporation. Measurements of actual evapotranspiration have been made to correlate with atmometer data. Many questions exist as to exactly what the difference of evaporation between black and white atmometers measures. The approach provided a reasonable means of estimating evapotranspiration for determining the water requirement of various crops. The ap-

proach has given results as good as those from U. S. Weather Bureau Class A evaporation pans in presently developed areas. In unirrigated areas, the use of atmometers is superior to the use of evaporation pans for estimating potential water requirements of crops. (Blecker-Ariz)
W69-05685

FLUCTUATIONS IN WATER DROPLET EVAPORATION RATES,
New Mexico Univ., Albuquerque.
Howard C. Bryant.
Research Project Technical Completion Report to the Water Resources Research Institute, New Mexico State University, June 1968. 5 p, 2 ref. OWRR Project A-014-NMex.

Descriptors: Acoustics, Air-water interfaces, Analytical techniques, Boundary processes, Cloud physics, Diffusion, *Drops, Electromagnetic waves, *Evaporation, Heat balance, Hygrometry, Instrumentation, Latent heat, Light penetration, Liquids, *Optical properties, Remote sensing, Resonance, Standing waves, Surface tension, Theoretical analysis, Vapor pressure, Vibrations, Volatility, *Water properties.

The rate at which a motionless droplet evaporates can be measured continuously and precisely by determining the period of the intensity fluctuation of laser light reflected off the center of the droplet. The back-scattered light is the coherent sum of light reflected from the external and the internal surfaces of the droplet; under typical conditions the backscattered light intensity oscillates at about 2 or 3 Hz. This method is applied to pure water droplets in the diam range from 0.6 to 1.8 mm, supported by bead thermistors and beaded glass fibers, and the results are compared to the 'quasi-stationary' theory of Maxwell. Our measurements show that, after steady state is reached, the rate of change of diam is inversely proportional to the diam, as predicted in the quasi-stationary theory. Our experiments give a somewhat slower evaporation rate than the theory predicts; this discrepancy can be eliminated if one assumes that the surface temperature of the droplet is somewhat lower than measured with the bead thermistor. No significant systematic fluctuations were found in the evaporation rate. Using the optical method mechanical resonances of the droplet can be sensitively detected; acoustically-induced shape resonances are briefly investigated.
W69-05750

THE EFFECTS OF WAVES ON EVAPORATION FROM A FREE WATER SURFACE,
Cornell Aeronautical Lab. Inc., Buffalo, N. Y.
Calvin C. Easterbrook.
Pap, Amer Geophys Union Meet, San Francisco, Calif, Dec 1968. 21 p, 9 fig.

Descriptors: *Waves (Water), Water vapor, Water surface, Wind tunnels, Wind speed, Wind velocity, Mass transfer, *Evaporation, Water resources, Model tests, Reservoirs, *Reservoir evaporation, Laboratory tests, Field investigations, Lakes.
Identifiers: *Wave height, Evaporation coefficient, Lake Hefner (Okla), Water vapor transmission, Wind waves, Wave tanks.

Laboratory and field measurements show that waves on a water surface have a significant effect on the evaporation rate. Laboratory studies were made with a combination wave tank and wind tunnel apparatus and controlled wind speed and wave parameters. Experimental results indicate that evaporation rates are lower under certain wind speed and wave height conditions than under similar wind speed and no wave conditions. Laboratory findings were supported by field evaporation measurements at Lake Hefner, Okla, using the eddy flux method. The dependence of evaporation on wave structure is attributed to changes in vertical mass transport through modification of the airflow pattern over the water surface. (USBR)
W69-05840

THE EVAPOTRANSPIRATION COMPONENT OF A PASTORAL EXPERIMENTAL CATCHMENT,
Soil Conservation Authority, Kew (Australia).
F. X. Dunin.
J Hydrol, Vol 7, No 2, pp 147-157, Jan 1969. 11 p, 1 fig, 5 tab, 3 ref.

Descriptors: *Evapotranspiration, *Hydrologic budget, Mathematical models, Water balance, Antecedent precipitation, Runoff, Moisture stress, Rainfall-runoff relationships, Demonstration watersheds, Model studies, Soil water movement.
Identifiers: *Australia, Potential evapotranspiration, Parwan Experimental Area (Australia).

The amount of evapotranspiration occurring from a pastoral catchment was determined by an assessment of the hydrologic balance within the catchment. A measure of the variable for changes in water content was achieved by the evaluation of soil store deficits antecedent to runoff events. Thus, the intervals of time for the determination of the amounts of evapotranspiration were confined to periods between runoff events. For those intervals when the index of topsoil moisture stress did not exceed a pF value of 3.5, a ratio of one existed between measured evapotranspiration and the index of potential evapotranspiration. With the use of this ratio in conjunction with the soil moisture record, variations in rates of evapotranspiration were presented for the years 1963 to 1966. Such data indicated that the prevailing land-use was inefficient in its consumption of water.
W69-05902

SOIL WATER MEASUREMENT WITH AN Am-241 Be NEUTRON SOURCE AND AN APPLICATION TO EVAPORIMETRY,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.
For primary bibliographic entry see Field 02G.
W69-05926

2E. Streamflow and Runoff

THE EFFECTS OF BENDS ON DISPERSION IN STREAMS,
California Univ., Berkeley.
Hugo B. Fischer.
Water Resources Res, Vol 5, No 2, pp 496-506, Apr 1969. 11 p, 4 fig, 5 tab, 14 ref.

Descriptors: *Dispersion, *Streamflow, *Channel morphology, *Meanders, *Missouri River, Diffusion, Path of pollutants, Tracers, Dye releases, Model studies, Hydraulic models, Mathematical models, Computer programs, Mixing, Turbulence.
Identifiers: Longitudinal dispersion, Green-Duwamish Rivers (Wash).

Bends in streams induce secondary currents that alter the rates of both transverse mixing and longitudinal dispersion. Within a bend the transverse mixing coefficient depends on the square of the mean velocity, cube of the depth, and inversely on the shear velocity and square of the radius of curvature, as verified by a laboratory experiment. The longitudinal dispersion coefficient depends on the channel geometry, velocity distribution, rate of transverse mixing, and a dimensionless parameter that includes the mean velocity and length of an average bend. A numerical program for predicting dispersion coefficients in streams differs from previous theories by including the effect of the alternating direction of curvature in a series of bends; the difference is important for wide streams but not for narrow ones. Experimental findings in 2 streams, the Green-Duwamish in Washington (width 20 m), and the Missouri near Omaha, Nebraska (width 180 m), verify the numerical program. (Knapp-USGS)
W69-05609

CONDITIONAL PROBABILITIES OF FAILURES IN RESERVOIR OPERATION FOR THE MORAN-GOULD MODEL,
City Univ., London (England). Dept. of Civil Engineering.
C. Venetis.
Water Resources Res, Vol 5, No 2, pp 514-518, Apr 1969. 5 p, 1 fig, 5 ref.

Descriptors: *Reservoir operation, *Reliability, *Probability, Markov processes, Stochastic processes, Statistical models, Digital computers, Forecasting, Water yield, Water management (Applied).
Identifiers: Moran-Gould reliability model.

A method is given to calculate the distribution of the number of reservoir failures using the Moran-Gould model as seasonal inflows. The reservoir content is taken to be a discrete random variable with probabilities depending only on the content at the beginning of the year, assuming the yearly inflows to be independent and the yield constant. The fluctuations of content are approximated by a homogeneous finite Markov chain. (Knapp-USGS)
W69-05612

UNIFIED VIEW OF DIFFUSION AND DISPERSION,
Illinois Univ., Urbana. Dept. of Civil Engineering.
For primary bibliographic entry see Field 01B.
W69-05619

SURFACE TENSION IN FROUDE MODELS,
Illinois Univ., Urbana. Dept. of Civil Engineering.
W. Maxwell, C. Hall, and J. Richard Weggel.
ASCE Proc, J Hydraul Div, Vol 95, No HY2, Pap 6482, pp 677-701, Mar 1969. 25 p, 9 fig, 1 tab, 8 ref, append. Grant NSF-GK-901.

Descriptors: *Hydraulic models, *Hydraulic similitude, *Surface tension, Viscosity, Steady flow, Unsteady flow, Reynolds number, Froude number, Weber number, Hydraulics, Open channel flow.
Identifiers: Froude models, Model scale, Surface tension effects, Surface tension control (Chemical).

A criterion for avoiding surface tension effects in Froude models is obtained analytically for uniform flows. Experiments show that surface tension does not, in practice, limit the scale in curvilinear flow Froude models. In uniform flows the least scale is determined by instrumentation accuracy and Froude number or by the need to exceed a limiting Reynolds number. The least scale is found by including a surface energy term in the energy equation or by considering the celerity of small free surface disturbances. The scale is chosen so that experimental reading error scatter will mask any dependence on surface tension. Experiments on 3 weir geometries, for which flow at one head is interpreted as an imperfect Froude model of flow at a different head, are used to examine surface tension effects in Froude models of curvilinear flows. The viscosity was kept essentially constant and the surface tension varied using an additive. For all practical purposes variations due to surface tension are masked by the inherent scatter of the data. (Knapp-USGS)
W69-05621

ASSESSING UPLAND RESERVOIRS USING A DAILY FLOW MODEL,
Federal Water Pollution Control Administration, Washington, D. C.
George K. Young, William P. Somers, William C. Pisano, and William N. Fitch.
Water Resources Res, Vol 5, No 2, pp 362-379, Apr 1969. 18 p, 5 fig, 8 tab, 13 ref.

Descriptors: *Reservoir operation, *Water management (Applied), *Model studies, *Synthetic hydrology, Mathematical models, Probability, Statistical methods, Markov processes,

Stochastic processes, Water demand, Water supply, Recreation, District of Columbia.
Identifiers: *Washington (DC).

A procedure is given for analyzing multisite upland reservoir storage for water supply at a downstream point. Synthetic monthly streamflow for 6 sites replicates mean, standard deviation, and lag correlation coefficient of historic data; a matrix of spatial correlations interrelates the sites. Factors translate flow to 7 reservoirs operated in 2 modes and 1 use point. The Thomas-Fiering formula, using lag-one correlation and coefficient of variation of historic daily flows and a random gamma variable, converts monthly flow to daily supply at the use point. Results comprise probabilistic analyses of deficiencies and reservoir performances. A study of the Washington, D. C. requirements for 1985 indicates that 6 upland reservoirs reduce the duration of a deficiency occurring once in a hundred years and that a smaller volume of nearby storage is an alternative or can be used for standby. Sophisticated operation of upstream reservoirs should enhance recreational values while concurrently satisfying supply requirements at Washington. (Knapp-USGS)
W69-05632

DOWNSTREAM VARIATIONS IN THE HYDRAULIC GEOMETRY OF STREAMS: SPECIAL EMPHASIS ON MEAN VELOCITY,
Geological Survey, Arlington, Va.
Charles W. Carlston.
Amer J Sci, Vol 267, pp 499-509, Apr 1969. 11 p, 4 fig, 1 tab, 5 ref.

Descriptors: *Channel morphology, *Discharge (Water), *Statistical models, Depth, Width, Velocity, Streamflow, Shape, Slopes, Rivers, Model studies, Digital computers, Computer models.
Identifiers: River morphology.

Mathematical and statistical solutions for the exact description of river hydraulic geometry are reviewed, and new data are analyzed. The least squares solution of Matalas and Gilroy was applied to 10 gaged river basins to relate width, depth, and mean velocity to discharge. Downstream increase in discharge relates to downstream changes in geometry by a power function with exponents determined by Leopold and Maddock to be 0.5 for width, 0.4 for depth, and 0.1 for velocity. The least squares solution for the mean exponents of the 10 basins is w=0.461, d=0.333, and v=0.155. Studies in the Susquehanna basin show equal numbers of streams with downstream increases and decreases of velocity. Dye studies on 3 rivers over distances of 190 to 806 mi show constant velocity. Leopold shows that large-scale river floods that move much sediment have constant velocity. Large rivers accommodate downstream discharge increase mainly by depth increase, whereas smaller rivers generally accommodate the downstream discharge increase by width increase. (Knapp-USGS)
W69-05639

PRELIMINARY WATER YIELDS AFTER TIMBER HARVEST ON CASTLE CREEK, ARIZONA WATERSHEDS,
Arizona Univ., Tucson. Rocky Mountain Forest and Range Experiment Station.
For primary bibliographic entry see Field 03B.
W69-05642

WATERSHED PLANNING,
Forest Service (USDA), Tempe, Ariz. Forest Hydrological Lab.
For primary bibliographic entry see Field 03B.
W69-05643

SANTA YNEZ BAROMETER WATERSHED,
Los Padres National Forest, Santa Barbara, Calif.
For primary bibliographic entry see Field 03B.
W69-05644

FLOOD PLAIN INFORMATION, ROCK RIVER AT BELOIT, WISCONSIN.
Corps of Engineers, Rock Island, Ill.
For primary bibliographic entry see Field 04A.
W69-05646

FLOOD PLAIN INFORMATION, IRWIN, LONG AND PAW CREEKS, CHARLOTTE, NORTH CAROLINA (VOLUME 1).
Corps of Engineers, Charleston, S. C.
For primary bibliographic entry see Field 04A.
W69-05647

FLOOD PLAIN INFORMATION, FORKED DEER RIVERS, AND LEWIS CREEK, IVERSBURG, TENNESSEE.
Corps of Engineers, Memphis, Tenn.
For primary bibliographic entry see Field 04A.
W69-05648

FLOOD PLAIN INFORMATION, CHEHALIS AND SKOOKUMCHUCK RIVERS, CENTRALIA-CHEHALIS, WASHINGTON.
Corps of Engineers, Seattle, Wash.
For primary bibliographic entry see Field 04A.
W69-05649

SUMMARY OF WATER RESOURCES DEVELOPMENT IN IRAN,
Ministry of Water and Power, Tehran (Iran).
H. Mahdavi.
For the 8 Volume Proceedings, see Vol 2, No 9, Field 06B and W69-03305. Int Conf on Water for Peace, Wash, D C, Vol 6, pp 68-77, 1968. 10 p.

Descriptors: *Water resources, *Surface waters, *Groundwater, Arid lands, Streamflow, Stream gages, Water wells, Water resources development, Water levels, Water utilization, Irrigation, Saline water, Salinity, Climates.
Identifiers: *Iran, Ghanats.

Iran, situated between 25 and 40 deg north latitude and 44 and 64 deg east longitude, covers 1.6 million sq km. The region is a high plateau surrounded by mountain ranges. In general, the climate is Mediterranean and arid or semiarid. Rainfall ranges from 50 to 300 mm over the interior lowlands and deserts and 500 to 2000 mm in the mountains. Most of the national population of 23 million is agrarian. Agriculture is developed mainly along the Caspian Sea coast, in the Lake Rezaieyeh area, and in many alluvial basins of various sizes where good quality water is available. Drainage into closed basins and contamination of surface waters and aquifers by evaporites and salt diapirs cause serious water quality problems, especially in the Central Basin and along the southern coast. Utilization of surface water and shallow groudnwater in the alluvial basins where historical dug wells and ghanats (underground drains) are common and have exploited many of the major sources of water in the basins. About 3000 deep wells produce 1,800 mcm (million cubic meters) per yr; 6,000 shallow-wells, 2,000 mcm; and 25,000 ghanats produce 12,000 mcm-a total of nearly 16,000 mcm per yr. Water levels have declined substantially in some places. Flow in major rivers of the country has been gaged continuously since 1943; more than 350 stations are now in operation. Since 1960 water resources studies have been carried out in 17 areas in various parts of the country. (Knapp-USGS)
W69-05651

WATER-RESOURCES APPRAISAL OF BUTTE VALLEY, ELKO AND WHITE PINE COUNTIES, NEVADA,
Geological Survey, Carson City, Nev.
For primary bibliographic entry see Field 02F.
W69-05656

INVESTIGATION OF SURFACE AND UNDERGROUND RUNOFF (RUSSIAN).
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
For primary bibliographic entry see Field 02A.
W69-05659

WATER CONSUMPTION IN THE LOWER COLORADO RIVER VALLEY,
Geological Survey, Yuma, Ariz. Water Resources Div.
Omar J. Loeltz, and Charles C. McDonald.
J Irrig and Drain Div, ASCE, Vol 95, No IR1, Proc paper 6457, pp 65-78, Mar 1969. 2 fig, 4 tab, 11 ref.

Descriptors: *Water consumption, *Colorado River, *Streamflow, *Withdrawal, *Flow measurement, Dams, Flood plains, Runoff, Inflow, Discharge (Water), Measurement, Municipal water, Hydrologic budget, Evapotranspiration, Irrigation water.

This paper makes an appraisal of water consumption in the flood-plain valley of the Colorado River between Davis and Imperial Dams. Average annual water consumption in the lower Colorado River Valley between the two dams during 1950-1966 was about 1,200,000 acre-feet. The average of values was computed by an inflow-outflow budget, and consumptive-use coefficients were applied to acreages. Estimates of water consumption computed by each method differed by as much as 115,000 acre-feet for some reaches. These differences were not considered unreasonable in view of large flows of the Colorado River relative to water consumed and uncertainties of many of the values of individual items of both methods. (Affleck-Ariz)
W69-05678

THE STATISTICAL MEASURE OF HYDROLOGIC TIME SERIES,
Agricultural Research Service, Riesel, Tex.
Walter G. Knisel, Jr., and Vujica Yevjevich.
Proc International Hydrology Symposium, Fort Collins, Colorado, Sept 6-8, 1967. Vol 1, pp 306-313, 5 fig, 1 tab, 4 ref.

Descriptors: *Hydrology, *Streamflow, *Time series analysis, Statistical methods, Markov processes, Mathematical models.
Identifiers: *Autocorrelation, Mean daily discharge, Stochastic models.

Hydrologic time series of streamflows for 17 rivers were analyzed to determine the information contained in discrete time series of varying time increments, delta t, as statistical measures of time series. Ten time increments were studied to determine which would indicate how the time series information changes with delta t. First, the time series was made second-order stationary by removal of the periodic component. Then, linear Markov models were applied to describe time dependence in the stochastic component of the series. Series of independent and random variable epsilon sub t in the stochastic component were determined for each delta t of each station. This residual variable of the stochastic component was studied to evaluate the effect of time increments, or statistical measure, on variance of the mean of epsilon sub t. It was found that for a discrete time series of size N= T/delta t (T= total length of continuous series) the information decreases with an increase of delta t or with a decrease of size N. A series of 50 annual values has less information than a corresponding series of 50 x 365 daily values of river flows. (Knisel-ARS)
W69-05775

WHITE V PENNSYLVANIA RR (DAMAGES FOR OBSTRUCTION OF STREAM).
For primary bibliographic entry see Field 06E.
W69-05794

HYDROLOGIC SIMULATION IN WATER-YIELD ANALYSIS,
Corps of Engineers, Sacramento, Calif.
Leo R. Beard.
Proc, Amer Soc Civil Eng, Vol 93, No IR 1, pp 33-42, Mar 1967. 10 p, 1 fig, 2 tab.

Descriptors: *Simulation analysis, *Synthetic hydrology, *Water yield, Design flow, Design data, Streamflow forecasting, Statistical methods, Hydrologic data, Water analysis.

Storage capacities required to maintain specific yields were determined independently for each half of 12 long streamflow records on unregulated streams. In two thirds of the cases, design varied by a factor to two, indicating the inadequacy of design based upon the repetition of past streamflows. A method was described for generating monthly streamflows that have the basic frequency and persistence characteristics of the recorded data. It was concluded that the simulated streamflows had the advantage that any length of record could be generated, and that the expected benefits and statistical consequences of particular capacities could be determined. (Gysi-Cornell)
W69-05849

USE OF INTERRELATED RECORDS TO SIMULATE STREAMFLOW,
Corps of Engineers, Sacramento, Calif.
Leo R. Beard.
Proc, Amer Soc Civil Eng, Vol 91, No HY5, pp 13-22, Sept 1965. 10 p, 4 tab, 3 ref, 1 append.

Descriptors: *Simulation analysis, *Digital computers, *Statistical methods, *Regression analysis, *Synthetic hydrology, Hydrologic data, Streamflow forecasting, Monte Carlo method.

An electronic computer procedure was described that extracted a maximum degree of pertinent information from monthly streamflow data and generated values whose statistical characteristics were consistent with those of the observed monthly streamflow. Multiple linear regression of the data transformed to unit normal standard deviates was used. A procedure was described for using data that were not simultaneous at all recorded locations and that would permit formulating an interrelated-streamflow generator for ungaged stations. (Gysi-Cornell)
W69-05850

A NONLINEAR HYDROLOGIC SYSTEM RESPONSE MODEL,
Illinois Univ., Urbana.
For primary bibliographic entry see Field 02A.
W69-05858

SIMULATION OF THE EVOLUTION OF DRAINAGE-BASIN NETWORKS WITH A DIGITAL COMPUTER,
Clarkson Coll. of Technology, Potsdam, N. Y.
Hilbert Schenck, Jr.
J Geophys Res, Vol 68, No 20, pp 5739-5745, Oct 15, 1963. 7 p, 6 fig, 5 tab, 7 ref.

Descriptors: *Simulation analysis, *Drainage systems, *Digital computers, *Networks, Analytical techniques, Water analysis, River basins, Monte Carlo method, Hydrologic data, Streamflow forecasting, Synthetic hydrology.
Identifiers: Random-walks, Gray's law.

The techniques of Monte-Carlo or random-walk computer simulation were used to generate hypothetical drainage-basin networks. Stream direction within the basin was controlled by random choice, subject only to the constraints that reverse flow and closed loops were not permitted. Resulting networks were analyzed and the results compared with field data. The computer generated networks compared closely with natural stream lengths and numbers of streams of various order. Comparison was also made with Gray's area-length correlation. Gray's law was roughly predicted by the random walk models. (Gysi-Cornell)
W69-05859

THE INFILTRATION COMPONENT OF A PASTORAL EXPERIMENTAL CATCHMENT, PARTS 1 AND 2,
Soil Conservation Authority, Kew (Australia).
For primary bibliographic entry see Field 02G.
W69-05901

THE EVAPOTRANSPIRATION COMPONENT OF A PASTORAL EXPERIMENTAL CATCHMENT,
Soil Conservation Authority, Kew (Australia).
For primary bibliographic entry see Field 02D.
W69-05902

RELIABILITY ESTIMATES FOR A STORAGE RESERVOIR WITH SEASONAL INPUT,
Slovak Academy of Sciences, Bratislava (Czechoslovakia). Inst. of Hydrology and Hydraulics.
For primary bibliographic entry see Field 06A.
W69-05906

FLOODS IN BEECHER EAST QUADRANGLE, NORTHEASTERN ILLINOIS,
Geological Survey, Washington, D. C.
Howard E. Allen, and Allen W. Noehre.
Geol Surv Hydrol Invest Atlas HA-302, 1 sheet, 1969. 8 fig, 1 map, 2 tab, 4 ref.

Descriptors: *Floods, *Stage-discharge relations, *Illinois, Hydrologic data, Data collections, Duration curves.
Identifiers: Beecher (Ill), Recurrence intervals, Flood frequencies, Flood profiles.

Hydrologic data are presented to be used to evaluate the extent, depth, and frequency of flooding that may be expected in the Beecher East quadrangle, northeastern Illinois. The flooded area is shown on a topographic map scaled 1:24,000. Flood profiles, cross sections, and frequency curves show heights and probabilities of past and predicted floods. (Knapp-USGS)
W69-05911

FLOODS IN NEW YORK- 1967,
Geological Survey, Albany, N. Y.
F. L. Robison.
N Y Water Resources Comm Rep of Invest RI-3, 1969. 32 p, 10 fig, 1 tab.

Descriptors: *Floods, *Data collections, *New York, Rainfall-runoff relationships, Hydrographs, Hyetographs, Hydrologic data, Discharge (Water).
Identifiers: Cattaraugus County (NY).

Information on floods in New York State in 1967 is presented. The only major flood of the year was in the western third of the state, Sept. 27-29, when a record rainfall of 6.54 in. in 28 hr caused widespread flooding and damages of over $1,250,000 in Cattaraugus County. Hyetographs and hydrographs show the rainfall-runoff relationship. Sites reporting flood damages are mapped. Newspaper items describing flood damages of 1967 are reprinted. Flood stages and discharges are tabulated. (Knapp-USGS)
W69-05912

FLOOD PLAIN INFORMATION, CONLEY CREEK-SOUTH RIVER, METROPOLITAN ATLANTA, GEORGIA.
Corps of Engineers, Savannah, Ga.
For primary bibliographic entry see Field 04A.
W69-05913

FLOOD PLAIN INFORMATION, CASEY CANAL SOUTH, SAVANNAH AND CHATHAM COUNTY, GEORGIA.
Corps of Engineers, Savannah, Ga.
For primary bibliographic entry see Field 04A.
W69-05914

COST OF RESERVOIRS IN ILLINOIS,
Illinois State Water Survey, Urbana.
For primary bibliographic entry see Field 06C.
W69-05915

MARKOV CHAIN STORAGE MODELS FOR STATISTICAL HYDROLOGY,
Cornell Univ., Ithaca, N. Y.
For primary bibliographic entry see Field 07C.
W69-05917

RELIABILITY OF WATER SUPPLY PERFORMED BY MEANS OF A STORAGE RESERVOIR WITHIN A LIMITED PERIOD OF TIME,
Slovak Academy of Sciences, Bratislava (Czechoslovakia). Inst. of Hydrology and Hydraulics.
Vit Klemes.
J Hydrol, Vol 5, No 1, pp 70-92, Mar 1967. 23 p, 9 fig, 3 tab, 10 ref, append.

Descriptors: *Water management (Applied), *Water storage, *Water supply, *Reliability, *Statistical methods, Reservoir yield, Optimization, Probability, Reservoir operation, River forecasting, Usable storage, Computers, Digital computers.
Identifiers: Reservoir reliability, Water supply probability.

The reliability of water supply is characterized by the portion of non-failure years in the period concerned. Although this portion, called certainty, tends to a constant value as the length of the period increases (in case of a finite reservoir and stationary processes of input and output), it varies considerably within short periods. This fact is of a practical importance, since the estimations of storage-reservoir effectiveness can seldom take into account more than 30-40 future years. A method is presented for straightforward computation of the certainty-distribution within a limited period of time, for random input and uniform or random reservoir-draft. A practical example has been solved by means of this method, using a digital computer. The results obtained are calculated and shown graphically.
W69-05930

ANALYSIS OF FLOOD PROCESSES IN DRAINAGE AREAS OF VARYING SEEPAGE CHARACTER (RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
M. F. Skribnyy.
In 'Invest of Surface and Underground Runoff', (Issledovaniye Poverkhnostnogo i Podzemnogo Stoka), Moscow, 'Nauka', pp 116-140, 1967. 25 p, 7 fig, 1 tab.

Descriptors: *Flood plains, *Floodwater, *Drainage systems, *Drainage effects, *Soil surfaces, Soil textures, Soil types, Runoff, Basins, Rain, Snow, Glaciers, Floods, Filtration, Turbulent flow, Laminar flow, Mathematical studies.
Identifiers: *Far East (USSR).

Flood processes were investigated on the basis of earlier detailed analytical studies and on some experimental verifications. In general the study is based on the concept that an understanding of flood genesis should be based on the study of both flood origins, such as rain, snow, glaciers, etc., and the character of rocks that form the upper layer of a drainage basin. The article contains the following chapters: (1) classification of small drainage basins on the basis of their surface structure and their flow characteristics; (2) natural characteristics of drainage basins with rocky permeable ground; (3) natural characteristics of swampy drainage basins; (4) investigation of flows characterized by seepage; (5) fundamental equations of flood motions; (6) flood motion under rain conditions; (7) determination of maximum discharges; (8) the construction

of Q=f(t) diagrams for maximum floods; (9) variable deposition intensity with respect to time; (10) flood motion after the rain; (11) flood motion during the rain of variable intensity; (12) flow velocities characterizing the drainage basins with rocky permeable surfaces; (13) flow velocities characterizing the swampy drainage systems. The article contains 51 formulas. (Gabriel-USGS)
W69-05940

GENERALIZED EXPRESSION FOR THE CONNECTION BETWEEN THE KINEMATIC AND MORPHOLOGIC ELEMENTS OF RIVER FLOW (IN RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
G. V. Zheleznyakov.
In 'Invest of Surface and Underground Runoff', (Issledovaniye Poverkhnostnogo i Podzemnogo Stoka), Moscow, 'Nauka', pp 141-143, 1967. 3 p.

Descriptors: *River flow, *Hydraulics, *Mathematical studies, *Parametric hydrology, Hydrologic equation, Hydrologic properties, Dynamics, Flow characteristics, Flow profiles, Channel morphology.
Identifiers: *USSR, Kinematic elements of streamflow.

Morphologic and kinematic elements of streamflows, were analytically investigated on the basis of Talmaza's analytical study (Kirkiz, SSR AN, 1964) modified to some extent by the author. The study shows that the mean value of a velocity parameter K, which is the logarithmic velocity profile, is a function of the mean and dynamic stream velocities. The investigation also shows that the maximum stream velocity, Vmax, may be considered as one of the most important kinematic stream characteristics. The author briefly discusses the analytical contributions made by Glushkov (AN USSR, 1961) and Altunin (M, 1962) in their studies of the morphologic and kinematic parameters of streamflows. The article contains 10 formulas. (Gabriel-USGS)
W69-05941

ANALYSIS OF THE FORMATION OF RAIN FLOODS IN SMALL BASINS (IN RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
I. L. Zimont.
In 'Invest of Surface and Underground Runoff', (Issledovaniye Poverkhnostnogo i Podzemnogo Stoka), Moscow, 'Nauka', pp 144-153, 1967. 10 p, 3 fig, 4 ref.

Descriptors: *Floods, *Rain, *Rainfall-runoff relationships, *Rainfall intensity, Precipitation (Atmospheric), Flood plains, Flood forecasting, Runoff coefficient, Groundwater, Water measurement, Water balance, Mathematical studies.
Identifiers: *USSR, Siberia, Central Asia.

The formation of rain floods was investigated on the basis of mathematical and graphical studies of flood-balance elements given by Zimont (AN USSR, 1960 M). The author gives the formulas of duration and precipitation intensity expressed as the static moments of rain forms and the moments of inertia of these forms characterizing the rain precipitation, and suggests the evaluation of static moments, inertia moments, and mean slope profile characteristics characterizing the basins. Some suggestions on the distribution of hydrologic stations, water wells, and graphical interpretation of the data are also given. The article contains 14 formulas. (Gabriel-USGS)
W69-05942

CALCULATION OF MAXIMUM WATER DISCHARGES ORIGINATING FROM RAIN AND SNOW (IN RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
G. V. Zheleznyakov, and B. B. Danilevich.
In 'Invest of Surface and Underground Runoff', (Issledovaniye Poverkhnostnogo i Podzemnogo Stoka), Moscow, 'Nauka', pp 154-161, 1967. 8 p, 1 tab, 3 ref.

Descriptors: *Runoff, *Rain, *Snowmelt, *Analytical techniques, Discharge coefficients, Water measurement, Water types, Mathematical studies, Mathematical models, Meltwater, Swamps, Hydrologic equation, Hydrologic properties.
Identifiers: *Ukraine, USSR, Moldavio, Crimea.

The analytical methods developed by A. V. Ogiyevskiy and his co-workers for the calculation of maximum water discharges are here analyzed and modified. The analysis of a formula for the maximum rain-water discharges developed by P. F. Vishnevskiy (AN Ukr.SSR, 1961) shows that the more exact water-yield values and their duration are necessary to obtain better results. The analysis of a formula developed by V. I. Moklyak (AN Ukr.SSR, 1962) for the determination of maximum snow-water discharges shows that the results of the application of this formula may be considered as satisfactory, although certain improvement may be desirable. The article contains 35 formulas. (Gabriel-USGS)
W69-05943

MUD FLOWS IN THE TRANSILIAN ALA-TAU AND THE MUD FLOW CATASTROPHE OF 7 JULY, 1963 IN THE ISSYK RIVER BASIN (IN RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
G. D. Rozhdestvenskiy.
In 'Invest of Surface and Underground Runoff', (Issledovaniye Poverkhnostnogo i Podzemnogo Stoka), Moscow, 'Nauka', pp 162-168, 1967. 7 p, 4 photo, 4 ref.

Descriptors: *Mudflows, *Mud, *Diasters, Snowmelt, River basins, Hydrologic properties, Geologic control, Geomorphology, Flow characteristics, Flow control, Lakes, Waterfalls, Damages, Dam failure, Flood damage.
Identifiers: *USSR, Kazkh and Kirgiz SSR, Issyk River basin.

After briefly discussing the history of mud-flow activities in the Soviet Union (Central Asia, Northern Caucasus, etc.) and abroad (San Gabriel, U.S.A.), the author describes in detail the hydrologic and geologic characteristics of Lake Issyk area prior to 7 July 1963 and after the mud flow catastrophe, and the hydrological and geological conditions of the Issyk River basin after the catastrophe. The estimated volume of mud flows into Issyk Lake was 2 to 3 million cu m and the volume of water outflow from the lakes was 17 million cu m. The maximum flood flow reached 1,000 cu m/sec. This lake water greatly deepened the channel of the Issyk River and flooding destroyed many buildings and roads. (Gabriel-USGS)
W69-05944

IMMENSE LANDSLIDE OBSTRUCTION OF ZERAVSHAN RIVER, APRIL 24, 1964 (IN RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
G. D. Rozhdestvenskiy.
In 'Invest of Surface and Underground Runoff', (Issledovaniye Poverkhnostnogo i Podzemnogo Stoka), Moscow 'Nauka', pp 175-176, 1967. 2 p, 3 ref.

Descriptors: *Obstruction to flow, *Landslides, *Runoff, *Discharge, *Precipitation excess, Precipitation gages, Snow, Glaciers, Snowmelt, Drainage program, Canal construction, Damages.
Identifiers: *USSR, *Central Asia, Zeravshan River.

This article describes the April 24, 1964 landslide and the hydrological and geographical conditions present in the Zeravshan basin before and after the obstruction took place. In April 1964 very intensive precipitation occurred in the area and as a result of it a landslide of 20 million cu m in volume obstructed the flow of Zeravshan River on April 24, 1964. The river obstruction was 160 m in height and 800 m in width. As a result of this landslide 90 million cu m of water collected in 13 days behind the landslide dam. Rapid construction of a bypass canal helped minimize the damage done by this obstruction. The author recommends a series of investigations in the river basin in order of minimizing the damage that may occur from future landslides. (Gabriel-USGS)
W69-05946

ANALYTICAL METHOD OF COMPUTING MONSOON FLOODS (KELANI GANGA RIVER BASINS AS AN EXAMPLE) (IN RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
M. F. Skribnyy.
In 'Invest of Surface and Underground Runoff', (Issledovaniye Poverkhnostnogo i Podzemnogo Stoka), Moscow, 'Nauka', pp 177-186, 1967. 10 p, 1 fig, 4 tab.

Descriptors: *Floods, *Monsoons, *River basins, *Channel morphology, Precipitation intensity, Rainfall intensity, Instrumentation, Maximum probable flood, Hydrologic data, Hydrologic equation, Hydrologic properties, Mathematical studies, Mathematical models.
Identifiers: *Ceylon, Kelani Ganga River.

Some analytical formulas derived by Skribnyy (M. AN USSR, 1959) are modified and applied to the hydrological data observed in the Kelani Ganga River basin for a number of years. These analytical equations are primarily concerned with the establishments of the quantitative characteristic of a hydraulic channel parameter as a function of the channel form and channel roughness, as well as of the river slope and river bed sinuosity. Hydrologic data are analyzed by giving a classification of basin reliefs and climatic parameters, such as daily precipitation intensity, 1% discharge frequency, etc. Discussions are divided into topics on general characteristics of floods, initial formulas, determination of climatic parameters, and analysis of the Kelani Ganga River flood at 2 gaging stations. The article contains 15 formulas. (Gabriel-USGS)
W69-05947

COMPUTATION OF ANNUAL NORMAL FLOW OF INTERMITTENT WATERCOURSES AND MOUNTAIN RIVERS IN THE UKRAINIAN CARPATHIANS,
Ukrainskii Nauchno-Issledovatelskii Gidro-Meteorologicheskii Institut, Kiev (USSR).
A. N. Befani, and O. N. Mel'nichuk.
Transl from Trudy Ukr Nauch-Issled Gidromet Inst, No 69, 1967, pp 105-137. Soviet Hydrol, Selec Pap, No 6, pp 606-632, 1967. 27 p, 12 fig, 4 tab, 8 ref.

Descriptors: *Statistical methods, *Streamflow, Frequency analysis, Time series analysis, Hydrograph analysis, Groundwater, Recharge, Rainfall-runoff relationships, Routing, Streamflow forecasting, Runoff forecasting.
Identifiers: *Ukrainian Carpathians, USSR, Normal annual flow.

The concept of normal annual flow is defined and values are computed and compiled for 101 gaging stations on intermittent streams in the Ukrainian Carpathians. Short-term runoff and groundwater flow parameters are assumed to vary, not from a constant long-term normal, but from a cyclically time-variable parameter. The problem of computing the annual runoff includes the derivation of the cyclicity equation and evaluating the frequency of various deviations from this equation. The construction of regional runoff maps is reviewed. (Knapp-USGS)
W69-05950

COMPUTATIONS OF LEVEL CHANGES AND RUNOFF DISTRIBUTION IN A DELTA BASED ON OBSERVATIONAL DATA (DANUBE DELTA AS AN EXAMPLE),
State Oceanographic Institute, Moscow (USSR).
V. N. Mikhaylov, G. N. Gan, and T. A. Makarova.
Transl from Trudy Gos Okeanogr Inst, No 89, 1967, pp 140-160. Soviet Hydrol, Selec Pap, No 6, pp 632-649, 1967. 18 p, 3 fig, 12 tab, 7 ref.

Descriptors: *Streamflow, *Deltas, *Sedimentation, *Water level fluctuations, Sediment transport, Regime, Discharge (Water), Stage-discharge relations, Routing, Winds, Tides.
Identifiers: *Danube River.

Using the Danube delta as an example, approximate methods for computing the spatial distribution of level, water runoff, and sediment runoff are described. The computations are based on graphs of correlation of the corresponding levels for calm periods, discharge curves and curves showing the correlation between water and sediment runoff and graphs showing the correlation between synchronously measured water discharge, sediment discharge and turbidity, all based on observational data. Results of computations made by different methods are compared.
W69-05951

FORMATION OF A RIVER MOUTH BAR WHERE MARINE FACTORS PLAY AN IMPORTANT ROLE (EXEMPLIFIED BY THE LIELUPE RIVER),
State Oceanographic Inst., Moscow (USSR).
For primary bibliographic entry see Field 02J.
W69-05952

SOME PATTERNS OF FORMATION OF A RIVER MOUTH BAR WHERE RIVER FACTORS PLAY AN IMPORTANT ROLE (EXEMPLIFIED BY THE VISTULA DELTA),
State Oceanographic Institute, Moscow (USSR).
For primary bibliographic entry see Field 02J.
W69-05953

2F. Groundwater

FLUID FLOW IN THE WESTERN CANADA SEDIMENTARY BASIN. 2. EFFECT OF GEOLOGY,
Research Council of Alberta, Edmonton.
Brian Hitchon.
Water Resources Res, Vol 5, No 2, pp 460-469, Apr 1969. 10 p, 7 fig, 17 ref.

Descriptors: *Hydrogeology, *Geohydrological units, Aquifers, Groundwater basins, Groundwater movement, Water resources, Flow nets, Flow profiles, Flow rates, Water levels, Potentiometric level.
Identifiers: *Western Canada Sedimentary Basin.

The observed effect of variations of geology on the fluid potential distribution in the Western Canada basin is treated by considering the 3-dimensional flow net by stratigraphic units. Hydraulic head distribution maps for 27 stratigraphic units were prepared, and those from the Upper Devonian Beaverhill Lake Formation, Woodbend and Wabamum Groups and the Lower Cretaceous Mannville Group and Viking Formation are illustrated. The low fluid-potential drain that exists within the Upper devonian and Carboniferous carbonate rocks itself contains drainage channels belonging to different fluid potential subsystems. Excellent examples of these subsystems are found in the carbonate reef complexes of the Beaverhill Lake Formation and the Woodbend Group. Drawdown of the fluid potentials by some of the low fluid-potential channels is reflected through up to 2500 ft of strata and across a major unconformity. In general, relatively highly permeable beds significantly affect the regional fluid potential distribution, although the dominant features are topographically controlled. An apparently 3-dimensionally closed hydraulic head low in the Viking Formation is most probably the result of the chemico-osmotic potential coupled with the regional elevation and pressure potential. (Knapp-USGS)
W69-05602

HYDROLOGY, SOIL PROPERTIES, CROP GROWTH AND LAND DRAINAGE,
Institute for Land and Water Management Research, Wageningen (Netherlands).
J. Wesseling.
Soil-Water-Plant, Proc and Inform No 15, Comm for Hydrol Res T.N.O., pp 9-27, 1969. 19 p, 10 fig, 2 tab, 30 ref.

Descriptors: *Drainage, *Soil water, Mathematical methods, Hydrology, Porosity, Permeability, Climates, Evapotranspiration, Crop response, Moisture availability, Saline soils, Water inuury, Drainage practices, Water table, Drainage effects, Land management, Soil water movement.
Identifiers: *Netherlands.

Soil drainage for crop production is discussed. Both steady and unsteady flow equations for drainage are listed. Solutions are given for computing water table depths for any given drainage system if permeability, effective porosity, and climatological data are available. Although some solutions are complex, application is nearly always possible with modern computation techniques and equipment. The effect of water table depth on productivity is not accurately known, and depends largely on climate. In humid climates, a depth of 20-30 cm is effective. In arid regions deeper levels must be maintained to control salinization. The minimum depth otherwise is a function of soil aeration, and several diffusion equations are given, but crop requirements are largely unknown. Optimum water depths must be based on local experience. (Knapp-USGS)
W69-05607

EVALUATION OF THE RATE OF FLOW THROUGH POROUS MEDIA USING ELECTROKINETIC PHENOMENA,
Egyptian Desert Inst., Cairo; and Utah Water Research Lab., Logan.
Mohamed M. I. Abaza, and Calvin G. Clyde.
Water Resources Res, Vol 5, No 2, pp 470-483, Apr 1969. 14 p, 15 fig, 11 ref.

Descriptors: *Flow measurement, *Porous media, *Electrical properties, *Electric currents, *Tracers, Ion transport, Solutes, Chlorides, Groundwater movement, Discharge (Water), Borehole geophysics, Model studies, Permeameters.
Identifiers: Streaming potential, Electrokinetic effect.

An analytical relationship is developed that relates the rate of flow through porous media to the streaming current I and streaming potential E induced by the flow. Thus, a measurement of either E or I would give a value related to the rate of flow. Laboratory experiments were conducted to test the analytical relationship. The effects of the concentration of dissolved salt in the percolating solutions, the size of the particles forming the beds, and the temperature of the solution on the streaming current and the streaming potential are determined. The analytical relationships, together with the experimental work, form the basis of a method of measuring the rate of flow through porous media. (Knapp-USGS)
W69-05611

ON THE RELATION BETWEEN TRANSPIRATION, SOIL PHYSICAL PROPERTIES AND CROP PRODUCTION AS A BASIS FOR WATER SUPPLY PLANS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 02I.
W69-05613

FLOW RATES IN TWO-DIMENSIONAL, UNSTEADY, CONFINED GROUNDWATER FLOW,
Washington Univ., Seattle. Dept. of Civil Engineering.
Bruce W. Hunt.
ASCE Proc, J Hydraul Div, Vol 95, No HY2, Pap 6451, pp 603-608, Mar 1969. 6 p, 2 ref, append.

Descriptors: *Unsteady flow, *Groundwater movement, Aquifers, Mathematical models, Permeability, Saturated flow, Steady flow.
Identifiers: *Confined aquifers.

The theory of 2-dimensional unsteady confined groundwater flow is reviewed and extended to allow unsteady flow rates to be computed from steady-state solutions. Analysis of the method shows that unsteady flow rates closely approach flow rates calculated by replacing constant heads in the steady-state solutions with time-variant heads. The difference between steady and unsteady flow rates is small when aquifer permeability is small and when heads at the aquifer boundary vary slowly with time. (Knapp-USGS)
W69-05617

UNIFIED VIEW OF DIFFUSION AND DISPERSION,
Illinois Univ., Urbana. Dept. of Civil Engineering.
For primary bibliographic entry see Field 01B.
W69-05619

REFERENCES FOR WELL DATA AND WATER LEVELS IN CALIFORNIA BY THE GEOLOGICAL SURVEY,
Geological Survey, Menlo Park, Calif.
J. S. Bader.
Geol Surv Basic-data Compilation Rep, 1969. 13 p, 2 fig, 65 ref.

Descriptors: *Bibliographies, *Data collections, *Hydrologic data, *California, Water levels, Water level fluctuations, Water wells, Observation wells.
Identifiers: Periodic observations.

References to reports containing tabulated basic groundwater and water well data for California are listed. Index maps show the areas for which data are available and the locations of observation wells. (Knapp-USGS)
W69-05623

ON THE TEMPERATURE OF WATER FLOWING THROUGH FRACTURES,
Oregon State Univ., Corvallis. Dept. of Oceanography; and Oregon State Univ., Corvallis. Dept. of Mathematics.
Gunnar Bodvarsson.
J Geophys Res, Vol 74, No 8, pp 1987-1992, Apr 15, 1969. 6 p, 1 ref. Grant GA-1250 (NSF).

Descriptors: *Water temperature, *Groundwater, *Fractures (Geology), Geothermal studies, Permeability, Heat transfer, Heat budget, Heat flow.
Identifiers: Fracture permeability.

Fluids flowing through fractures in impermeable rock exchange heat with the surrounding medium. The fundamental equations governing the transport of heat in such systems are given. Solutions are derived for the case of constant mass flow and the fluid entering the fractures with a temperature that is a sinusoidal function of time. The rock is assumed to be a homogeneous and isotropic conductor. Approximate solutions are derived for the case in which the temperature at the intake is an arbitrary function of time. The case involving weak oscillations in the mass flow is treated on the basis of a perturbation method. Finally, some of the solutions derived are extended to the case of the laminated solid where the fluid flows between the laminas. (Knapp-USGS)
W69-05624

DETERMINATION OF THE GROUND-WATER COMPONENT OF PEAK DISCHARGE FROM THE CHEMISTRY OF TOTAL RUNOFF,
Nova Scotia Dept. of Mines, Halifax.
George F. Pinder, and John F. Jones.
Water Resources Res, Vol 5, No 2, pp 438-445, Apr 1969. 8 p, 5 fig, 1 tab, 9 ref.

Descriptors: *Base flow, *Surface-groundwater relationships, *Water chemistry, Discharge (Water), Groundwater, Rainfall-runoff relationships, Runoff, Hydrograph analysis, Subsurface runoff.
Identifiers: Nova Scotia.

The groundwater component of stream discharge may be determined from the chemical characteristics of the stream water by using chemical mass-balance to relate total, direct, and groundwater runoff. To solve the mass-balance equation, it is necessary to estimate the chemical composition of the groundwater and direct-runoff components. The solute concentration of groundwater is determined from total runoff during base-flow; the chemical characteristics of direct-runoff are estimated from samples of total runoff collected from selected locations in a basin during peak discharge periods. In 3 small watersheds in Nova Scotia groundwater runoff constituted from 32 to 42% of peak discharge for the period of analysis. (Knapp-USGS)
W69-05628

THE VERTICAL MOVEMENT OF WATER IN STRATIFIED POROUS MATERIAL. 1. INFILTRATION.
Agricultural Research Council, Cambridge (England). Unit of Soil Physics; and Cambridge Univ. (England). School of Agriculture.
For primary bibliographic entry see Field 02G.
W69-05630

SUMMARY OF WATER RESOURCES DEVELOPMENT IN IRAN,
Ministry of Water and Power, Tehran (Iran).
For primary bibliographic entry see Field 02E.
W69-05651

WATER-RESOURCES APPRAISAL OF BUTTE VALLEY, ELKO AND WHITE PINE COUNTIES, NEVADA,
Geological Survey, Carson City, Nev.
Patrick A. Glancy.
Nev Dep Conserv and Nat Resources, Water Resources-Reconnaissance Ser Rep 49, July 1968. 50 p, 3 fig, 1 plate, 1 photo, 16 tab, 27 ref.

Descriptors: *Water resources, *Groundwater, *Surface waters, Arid lands, Water wells, Water yield, Safe yield, Alluvium, Aquifers, Irrigation water, Streamflow, Nevada.
Identifiers: *Butte Valley (Nev).

The water resources of Butte Valley, east-central Nevada, are surveyed. Butte Valley includes 2 topographically closed valleys with a total area of about 1,000 sq mi. The precipitation of 6 inches in the valley to 20 inches on the surrounding mountains is probably the main source of recharge to the alluvial valley-fill reservoir, but the exact recharge boundaries are unknown because of underlying pervious carbonate rocks. Only about 20 wells have been drilled, and they are all shallow. No wells tap the carbonate rocks, which are probably a significant groundwater reservoir. Natural discharge is mainly evapotranspiration and totals almost 20,000 acre-ft per yr. Only 5 streams are perennial. Mean annual runoff is low. The water quality of the area is good; all waters tested are good for most purposes. Streamflow is used for irrigation of about 2,000 acre, but groundwater is mainly underdeveloped. Pumpage probably did not exceed 35 acre-ft in 1967. The perennial yield of the area is about 20,000 acre-ft per yr. (Knapp-USGS)
W69-05656

INVESTIGATION OF SURFACE AND UNDERGROUND RUNOFF (RUSSIAN).
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
For primary bibliographic entry see Field 02A.
W69-05659

A STEP IN OPTIMIZING THE DEVELOPMENT OF THE BASAL WATER LENS OF SOUTHERN OAHU, HAWAII,
Hawaii Univ., Honolulu. Water Resources Research Center.
L. Stephen Lau, and J. F. Mink.
Artificial Recharge and Management of Aquifers, Proc Symp of Haifa (Mar 1967) Int Ass Sci Hydrol, Pub No 72, pp 500-508, 1967. 9 p, 2 fig.

Descriptors: *Groundwater, *Saline water-freshwater interfaces, *Water wells, *Water resources development, Municipal water, Hawaii, Cities, Water requirements, Aquifers, Hydrogeology, Springs, Water yield.
Identifiers: *Ghyben-Herzberg lens, Honolulu.

The city of Honolulu on the island of Oahu in the State of Hawaii obtains its fresh water supply almost entirely from a Ghyben-Herzberg lens that underlies the southern portion of the island. In addition to the city proper, many small communities and military bases derive their water from the same source so that an average of about 100 mgd of low salinity fresh water is pumped from the lens for domestic use. The largest developments, however, serve agriculture which utilizes up to 150 mgd. Thus the lens which underlies no more than 200 sq mi is subjected to intense development, the pace of which is quickening. Recently the city of Honolulu planned a new pumping station designed to withdraw 10 mgd from the lens to assure optimum development in the sense of minimizing degrading effects in other pumping areas. Extensive laboratory and field tests were conducted to determine the best location for the well field. Laboratory investigations consisted principally of modeling the field situation. On the basis of laboratory-field evaluations, the well field was located and is now successfully supplying Honolulu with additional water. (Knapp-USGA)
W69-05663

NEW THRUSTS IN GROUND WATER,
Geological Survey, Washington, D. C. Water Resources Div.
C. L. McGuinness.
Ground Water, Vol 7, No 2, pp 7-10, Mar-April, 1969. 2 ref.

Descriptors: *Groundwater, *Water management (Applied), *Aquifers, *Domestic water, *Water supply, Groundwater recharge, Water storage, Artificial recharge, Economic feasibility, Waste storage, Hydrogeology, Saline water, Fresh water, Desalination, Pollution abatement.

Four major trends in management and use of ground water were discussed in this report. The first trend was that ground water will be used increasingly for domestic water supplies. Quantitative evaluation of the water supply under conditions of maximum development will have to be conducted, instead of just determining availability of a supply that does not strain the aquifer. Increasing use of aquifers as possible storage media for surplus flood water in place of reservoirs was the second trend discussed. Geohydrologists will have to determine when, where, and how ground water reservoirs can be recharged artifically at a reasonable cost. Third, saline aquifers will be considered as sources of water supply. Fourth, aquifers will be looked to increasingly as possible storage media for industrial and domestic waste effluents as efforts to prevent stream pollution increase. In order to develop a working model of a given hydrologic and socio-economic problem from which quantitative answers can be given to water planners a systems analysis approach is needed. (Affleck-Ariz)
W69-05677

NUMERICAL SIMULATION OF UNCONFINED FLOW INTO A SINGLE PUMPING WATER-WELL USING TWO-PHASE FLOW THEORY,
Pennsylvania State Univ., University Park. Inst. for Research on Land and Water Resources.
Richard L. Cooley, and David A. T. Donohue.
Institute for Research on Land and Water Resources, Research Project Technical Completion Report, University Park, Pa., March 1969. 25 p, 2 fig, 1 append. 14-01-0001-1406, A-013-PA.

Descriptors: *Groundwater, *Mathematical model, *Computer programs, Aquifers, Pumping, Pore pressure, Permeability, Water flow, Drawdown.
Identifiers: *Two-phase flow, *Numerical simulation, *Single-pumping well, Cylindrical system, Unconfined flows.

The equations describing the flow of water from an aquifer into a single pumping well have been investigated and a general numerical technique has been proposed for their solution. Rather than requiring the usual, grossly simplifying assumptions in order to arrive at an analytical solution, the numerical simulation is applied to a second-order, nonlinear, partial differential equation which, with appropriate boundary and initial conditions, represents unsteady-state, two-phase flow in a cylindrical system. The alternating-direction-implicit-procedure (ADIP) is used to solve the appropriate equations on a high speed digital computer. Laboratory obtained correlations for capillary pressure and relative permeability functions were incorporated into the solution when necessary. The approach shows great promise and the study is being continued. (Sink-Penn State)
W69-05755

GROUND WATER FLOW SYSTEMS AND THE ORIGIN OF EVAPORITE DEPOSITS,
Idaho Bureau of Mines and Geology, Moscow.
Roy E. Williams.
Idaho Bureau of Mines and Geology Pamphlet No. 141, August 1968.

Descriptors: Mass transfer, *Mineral water, Salts, Water quality, Connate water, *Ground water movement.

The literature on evaporite mineral deposits suggests a functional relationship between the origin of these deposits and ground-water flow systems. Comparison of spatial distributions of groundwater quality with pertinent solutions to flow equations under specified boundary conditions reveals that quality of ground water is a function of flow path length, flow path route and flow velocity. Selected references provide evidence that sites of accumulation of non-marine evaporite minerals are discharge zones for poor quality water from regional ground-water flow systems. Isotope ratios in oil field brines and in standard mean ocean water indicates that water in some deep brines is of local meteoric origin; therefore, the brines are part of a ground-water flow system. Observed distribution of fluid potential in the saline portion of some groundwater flow systems on the Atlantic Coast of the United States reveals that saline ground water discharges toward the ocean floor. Therefore, ground water may also act as a transport medium for dissolved solids which are precipitated, under appropriate conditions, as marine evaporite desposits.
W69-05758

MECHANICS OF A MATHEMATICAL GROUND-WATER MODEL,
Wyoming Univ., Laramie; and Colorado State Univ., Fort Collins.
Frank J. Trelease, and Morton W. Bittinger.
Proc, Amer Soc Civil Eng, Vol 89, No IR1, pp 51-62, Mar 1963. 12 p, 3 fig, 8 ref, 1 append.

Descriptors: *Simulation analysis, *Groundwater basins, *Mathematical models, Water level fluctuations, Digital computers, Hydraulic properties, Aquifers, Pumping, Drawdown, Observation wells.
Identifiers: Fountain Creek (Colorado).

A mathematical model was structured to study groundwater problems in the Fountain Creek Valley of Colorado. To set up the groundwater model, the geohydraulic boundaries were located and idealized into straight lines, wells were grouped into pumpage centers, other inflows were idealized, and the model was tested to verify the assumptions. A digital computer was used to compute drawdowns in ten observation wells at 60-day intervals over a 3-year period for various aquifer and boundary conditions. Favorable agreement was obtained between computed and measured groundwater levels. (Gysi-Cornell)
W69-05863

SOME APPROXIMATE SOLUTIONS OF RADIAL FLOW PROBLEMS,
Indiana Univ., Bloomington. Dept. of Geology.
Yaron M. Sternberg.
J Hydrol, Vol 7, No 2, pp 158-166, Jan 1969. 9 p, 2 tab, 6 ref, 1 append.

Descriptors: *Groundwater movement, *Mathematical models, *Equations, Laplaces Equation, Unsteady flow, Porous media, Aquifers, Wells, Discharge (Water), Numerical analysis, Water wells, Withdrawal.
Identifiers: Laplace transformation, Exact solutions, Mellin's inversion, Radial flow.

A large number of exact solutions to various boundary value problems in ground water flow have been solved in recent years using Laplace transformation. For most of the radial flow problems, the transform does not have a simple inverse and various methods such as the Mellin's inversion formula must be employed. The resulting exact solution is frequently in a form of a complex integral or an infinite series which is difficult to evaluate. It is shown that an approximate inversion formula for Laplace transforms, developed for the solution of visco-elastic problems is applicable to most radial flow problems. Three cases are considered: (1) that of a well pumping a constant discharge from an infinite aquifer; (2) that of a well pumping a constant discharge from an infinite leaky aquifer; and (3) that of a well drawing an infinite leaky aquifer subject to a constant drawdown. The method leads to simple analytical solution for each of the above cases and agreement between this method and the exact solution for each case is excellent. (Knapp-USGS)
W69-05903

THE USE OF THE GEOELECTRIC METHOD FOR INVESTIGATING GEOLOGIC AND HYDROLOGIC CONDITIONS IN SANTA CLARA COUNTY, CALIFORNIA,
Santa Clara Valley Water Conservation District, Calif.
For primary bibliographic entry see Field 07B.
W69-05904

CHLORIDE CONCENTRATION IN GROUNDWATER, RECHARGE RATE AND RATE OF DEPOSITION OF CHLORIDE IN THE ISRAEL COASTAL PLAIN,
Stockholm Univ. (Sweden). International Meteorological Inst.; and Department of Natural Resources, Bangkok (Thailand).
Erik Eriksson, and Vachi Khunakasem.
J Hydrol, Vol 7, No 2, pp 178-197, Jan 1969. 20 p, 10 fig, 1 tab, 7 ref.

Descriptors: *Recharge, *Groundwater, *Groundwater movement, *Water quality, Chlorides, Precipitation (Atmospheric), Infiltration, Discharge (Water), Water balance, Hydrologic budget.
Identifiers: *Israel, Airborne salt deposition, Israel Coastal Plain.

The use of chloride concentrations in groundwater as indicators in estimating recharge rates is discussed. Published data from the Coastal Plain Aquifer in Israel are used in an example calculation. The method can be applied where rates of deposition of airborne chloride are known if the matrix of the aquifer does not also contribute chloride. The Coastal Plain aquifer consists of the sandy parts of a Cretaceous to Quaternary sequence of sands, limestones, clays, marls, and conglomerates. The direction of natural groundwater flow is seaward. The chloride deposition rate is about 20-30 kg/ha near the coast and decreases inland. The average recharge rate is calculated to be 92 mm per yr, or practically all the rainfall. This compares well with hydrologic budget computations. (Knapp-USGS)
W69-05905

COST OF MUNICIPAL AND INDUSTRIAL WELLS IN ILLINOIS, 1964-1966,
Illinois State Water Survey, Urbana.
For primary bibliographic entry see Field 06C.
W69-05910

NUMERICAL MODELING OF UNSATURATED GROUND WATER FLOW,
Kansas Univ., Lawrence.
Don W. Green, Charles F. Weinaug, and Hassan Dabiri.
Contrib No 31, Kans Water Resources Res Inst Proj Completion Rep, 1968. 105 p, 43 fig, 4 tab, 56 ref, 2 append (sep.-vol). OWRR Project B-011-KAN.

Descriptors: *Infiltration, *Soil water movement, *Unsaturated flow, *Mathematical models, Computer models, Digital computers, Computer programs, Numerical analysis, Permeability, Porosity, Unsteady flow, Hysteresis, Wetting, Drying.
Identifiers: Numerical modeling.

A mathematical model was developed to describe isothermal, 2-phase, 1- and 2-dimensional flow in porous media. The model was applied to the problem of vertical groundwater movement in unsaturated soils. The second-order nonlinear partial differential equations for 2-phase flow in porous media were converted to finite difference form and solved with an interative implicit digital computer procedure. The model treats permeabilities and capillary pressures as functions of saturation and computes hysteresis effects. Results of model computations were compared with results of a field test of saturation 22 ft beneath a pond. Neutron logs were run during wetting and drying periods. Agreement between calculated and measured results was excellent. (Knapp-USGS)
W69-05918

SEEPAGE FLOW ANALYSIS OF A SMALL POLDER IN THE SOUTHWESTERN PART OF THE NETHERLANDS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
N. A. De Ridder, and K. E. Wit.
J Hydrol, Vol 5, No 1, pp 47-57, Mar 1967. 11 p, 6 fig, 2 ref.

Descriptors: *Seepage, *Discharge (Water), Saline water, Aquifers, Drainage programs, Arable land, Drainage water, Land management, Land reclamation, Pumping, Flow nets, Water levels, Piezometry, Potentiometric level.
Identifiers: *Polder seepage, *Netherlands.

Seepage in a small polder was estimated by use of data from 32 observation wells in 2 underlying aquifers. Piezometric heads were analyzed mathematically and by use of flow nets. Salt supply to the polder was estimated, using the calculated inflow, to be 4.8 kg/ha per day in 1961, 2.4 in 1962, and to average about 3.4 kg/ha per day. The rate of seepage inflow is about 0.25 mm per day. The chloride concentration of the groundwater varies between 77 and 7500 mg/l. (Knapp-USGS)
W69-05927

SALT ACCUMULATION PROCESSES IN THE GROUND WATERS OF THE KIROVABAD-KAZAKH MASSIF,
Academy of Sciences of the Azerbaijanian, Baku (USSR).
R. I. Bagirova.
Transl from Dokl Akad nauk Azerb, SSR, Vol 23, No 12, 1967, pp 35-37. Soviet Hydrol, Selec Pap, No 6, pp 671-673, 1967. 3 p, 1 fig, 4 ref.

Descriptors: *Water quality, *Saline water, *Groundwater, *Water chemistry, Aqueous solutions, Sodium, Calcium, Sulfates, Bicarbonates.
Identifiers: *Kirovabad-Kazakh massif, USSR.

The relationships between total dissolved solids and the concentrations of individual ions in the groundwater of the Kirovabad-Kazakh massif, USSR, were determined and presented graphically. With increasing concentration, the waters change from bicarbonate-sodium-calcium to bicarbonate-sulfate sodium to sulfate-sodium, chloride-sulfate-sodium, and finally to chloride-sodium compositions. The total mineralization of the waters ranges from about 0.2 g/l to about 120 g/l. (Knapp-USGS)
W69-05954

2G. Water in Soils

HYDROLOGY, SOIL PROPERTIES, CROP GROWTH AND LAND DRAINAGE,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 02F.
W69-05607

ON THE RELATION BETWEEN TRANSPIRATION, SOIL PHYSICAL PROPERTIES AND CROP PRODUCTION AS A BASIS FOR WATER SUPPLY PLANS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 02I.
W69-05613

CALCULATION OF PARAMETERS FOR THE EVALUATION OF THE LEACHING OF SALTS UNDER FIELD CONDITIONS, ILLUSTRATED BY NITRATE,
Institute for Soil Fertility, Groningen (Netherlands).
G. J. Kolenbrander.
Soil-Water-Plant, Proc and Inform No 15, Comm for Hydrol Res, T. N. O., pp 59-73, 1969. 15 p, 7 fig, 2 tab, 10 ref.

Descriptors: *Leaching, *Soil water movement, Unsaturated flow, Irrigation effects, Nitrates, Percolation, Salts, Water quality, Clays, Soils, Rainfall, Diffusion.
Identifiers: Day's equation, Glueckaufs theory.

Mathematical methods for calculating the downward leaching of soil salts are reviewed and developed and parameters for various soils are determined and listed. The leaching of applied nitrate was studied on 8 different soil profiles under field conditions. The process can be described by the theory of Glueckauf, or with corrections, by the less complicated equation of Day. A distribution factor (K) was calculated for the 8 different soil profiles and was found to be closely related to the soil air content at pF=2.0. The value of K is about 8-12 cm at air contents higher than 10%; with small change with depth. Below 10% air, (in clay soils), K increases strongly with depth, because of subsoil cracks. It is impossible to use laboratory soil columns to determine K because disturbance of field conditions causes K to be about 1/3 the field value. (Knapp-USGS)
W69-05616

INSTALLATION AND FIELD CALIBRATION OF NEWTRON-SCATTER EQUIPMENT FOR

HYDROLOGIC RESEARCH IN HETEROGENEOUS AND STONY SOILS,
Department of Agriculture, University Park Pa. Northeast Watershed Research Center.
For primary bibliographic entry see Field 07B.
W69-05626

THE VERTICAL MOVEMENT OF WATER IN STRATIFIED POROUS MATERIAL. 1. INFILTRATION.
Agricultural Research Council, Cambridge (England). Unit of Soil Physics; and Cambridge Univ. (England). School of Agriculture.
E. C. Childs, and M. Bybordi.
Water Resources Res, Vol 5, No 2, pp 446-459, Apr 1969. 14 p, 9 fig, 1 tab, 14 ref.

Descriptors: *Infiltration, *Soil water movement, *Unsaturated flow, Soil profiles, Permeameters, Mathematical models, Percolation, Model studies, Hydraulic models.
Identifiers: Heterogeneous soil profiles, Vertical permeability.

The infiltration law of Green and Ampt is extended to include heterogeneous profiles. Formulas are developed to express 3 relationships. The infiltration law is derived for a profile consisting of a succession of n different layers with conductivity decreasing from the surface. An expression is derived for the conductivity profile that will give a specified infiltration law, and in particular a linear infiltration law with specified parameters. This expression serves to determine the conductivity when the infiltration law is observed. Experiments are described to measure the infiltration rates into layered columns or porous material, the results of which confirm the theory. (Knapp-USGS)
W69-05630

SALT AND WATER BALANCE, COACHELLA VALLEY, CALIFORNIA,
Agricultural Research Service, Riverside, Calif. Salinity Lab.; and Coachella Valley County Water District, Calif.
Charles A. Bower, James R. Spencer, and Lowell O. Weeks.
J Irrig and Drain Div, ASCE, Vol 95, No IR 1, Proc Paper 6437, pp 55-64, Mar 1969, 2 fig, 4 tab, 6 ref.

Descriptors: *Irrigated land, *Drainage effects, *Salt balance, *Water balance, *Leaching, Drainage water, Irrigation effects, Drains, Salts, California, Arid lands, Evapotranspiration, Soil chemistry, Tile drains, Input-output analysis, Ions.
Identifiers: *Coachella Valley, California, Salt balance index.

This study reported salt and water balance conditions in irrigated land by years for the period 1957-1965, and compared measured and calculated values for leaching and evapotranspiration as well as indicating nature and extent of chemical reactions occurring in soil as a consequence of irrigation. The salt balance index (output/input) for irrigated land was highly related to both area of irrigated land having tile drainage and leaching percentage, the index becoming close to one when about half the land became tiled and when leaching percentage increased to about 30. At salt balance evapotranspiration, taken as the difference between depths of applied and drainage water, agreed within about 10% of that calculated by the Blaney-Criddle formula. About 10% of the applied salt appeared to precipitate in soil largely as calcium carbonate and magnesium in water replaced exchangeable sodium in soil during irrigation operations. (Affleck-Ariz)
W69-05670

RELATIONSHIP OF TEXTURE TO SOME IMPORTANT SOIL MOISTURE CONSTANTS,
Punjab Agricultural Univ., Hissar (India). Dept. of Soils.
I. P. Abrol, B. K. Khosla, and D. R. Bhumbla.
Geoderma, Vol 2, 1968/1969, pp 33-39. 2 fig, 3 tab, 16 ref.

Descriptors: *Soil moisture, *Soil texture, *Moisture content, *Field capacity, *Correlation analysis, Wilting point, Semiarid climates, Soil profiles, Silts, Sampling, Clays, Calcium carbonate.
Identifiers: *India, Available water capacity.

A study was conducted to determine whether a relationship existed between soil texture and the soil moisture contents of field capacity, wilting point, and available water capacity of some semiarid region soils. Seventy-nine soil samples were collected from 14 profiles in the Hissar district of India. The major factor contributing to moisture held at 1/3 atmosphere was silt, while clay bore a highly positive and significant correlation with 15 atmospheres. There is a linear increase in available water capacity with increase in clay and silt content up to 50% clay and silt, beyond which there is a tendency for A. W. C. to decrease. It was suggested that calcium carbonate should be taken into account when inferring moisture constants from textural data. (Affleck-Ariz)
W69-05679

USE OF VEGETATION AS AN INDICATOR FOR SOIL PROPERTIES UNDER DESERT CONDITIONS,
Negev Inst. for Arid Zone Research, Beersheba (Israel).
Gideon Orshan, Uri Gavish, and Ilan Borovic.
Negev Institute for Arid Zone Research, Beer Sheva, 50 p, Mar 1968. 2 tab, 17 ref. U. S. Dept of Army DA-91-591-EC 3806.

Descriptors: *Root systems, *Desert plants, *Soil profiles, *Sierozems, *Soil-water-plant relationships, Irrigation effects, Sands, Soil properties, Habitats, Soil moisture, Arid lands, Competition, Vegetation effects.
Identifiers: *Israel, *Negev Desert.

Root systems of 13 leading species in sandy desert vegetation were excavated and described. They were classified into three types. The stability of root pattern and nature of soil layers penetrated by roots differed for the various species. In some cases they may account for plant distribution in the sandy soils of the Negev of Israel. Soil moisture was measured at 2 locations in the Negev Desert during summer, 1966, and its use by plants was discussed. At one location it was evident that plants mainly used soil moisture of the upper 90 cm and only to a smaller extent, soil moisture of deeper layers. No such differences in use of soil moisture from different soil layers were found at the second location. The effect of sand cover and irrigation on the competition between leading desert psamophytes was also examined. (Affleck-Ariz)
W69-05682

MOVEMENT OF WATER THROUGH SOIL AS INFLUENCED BY OSMOTIC PRESSURE AND TEMPERATURE GRADIENTS,
California Agricultural Experiment Station, Riverside.
J. Letey.
Hilgardia, Vol 39, No 14, pp 405-418, Nov 1968. 1 fig, 5 tab, 13 ref.

Descriptors: *Soil water movement, *Osmotic pressure, *Thermocline, *Flow, Darcys law, Hydraulic conductivity, Soil temperature, Equations, Vapor pressure, Salts, Temperature, Moisture content, Soil physics.
Identifiers: *Suction, Steady-state flow.

Darcy's Law has been used directly or combined with the continuity equation to produce equations to describe water flow through soils. In the use of these equations, it must be assumed that osmotic pressure or temperature gradients do not exist, or if such gradients do exist, their effects on water movement are negligible. Osmotic pressure and temperature gradients under many conditions, particularly irrigated arid lands, are readily recognized. The critical question is whether or not these gradients significantly effect the flow of water through soil. This paper presents equations for water flow which include the osmotic pressure gradient and the temperature gradient and reviews the information available on the effect of the osmotic pressure and temperature gradients on water flow through soil. (Affleck-Ariz)
W69-05683

AN AGROCLIMATOLOGY SURVEY OF A SEMIARID AREA IN AFRICA SOUTH OF THE SAHARA,
Joint FAO/UNESCO/WMO Interagency Project on Agroclimatology.
For primary bibliographic entry see Field 02I.
W69-05684

DESALINIZATION OF SOILS UNDER CONTROLLED UNSATURATED FLOW CONDITIONS,
California Univ., Davis. Dept. of Irrigation.
D. R. Nielsen, J. W. Biggar and J. N. Luthin.
Proc International Commission on Irrigation and Drainage, Sixth Congress, Vol 2, pp 19.15-19.24, 1966. 10 p, 6 fig, 10 ref.

Descriptors: *Unsaturated flow, *Desalination processes, *Soil water movement, *Saline soils, *Leaching, Ion transport, Land reclamation, Saturation, Infiltration, Solutes, Pores, Diffusion, Saturated soils, Salts, Rates of application, Soil surfaces, Ponding, Chlorides.

This paper suggests that efficiency of leaching a saline soil may be significantly increased by controlling the degree of water saturation and rate of water movement through the soil profile. In areas where infiltration rates are not a limiting factor, a sufficient number of intermittent applications could be made without adversely affecting the growing crop and yet accomplish sufficient leaching for continuous production. For a given quantity of water transported, solutes are moved through soils in markedly different manners. The processes involved are (1) variation in the pore water velocities, (2) ionic or molecular diffusion, and (3) interaction among solute ions, water and charged soil particle surfaces. (Blecker-Ariz.)
W69-05687

SOIL MOISTURE TRANSPORT DUE TO THERMAL GRADIENTS: PRACTICAL ASPECTS,
Agricultural Research Service, Kimberly, Idaho. Snake River Research Center.
J. W. Cary.
Soil Sci Soc Amer Proc, Vol 30, No 4, pp 428-433, July-August 1966. 3 tab, 23 ref, append.

Descriptors: *Thermal conductivity, *Soil moisture, *Thermocline, *Porous media, *Soil temperature, Thermal properties, Heat flow, Heat transfer, Soil surfaces, Temperature, Diurnal, Equations, Fluctuation, Flow characteristics, Moisture content, Cooling, Heating.
Identifiers: *Thermal moisture transport, *Soil moisture transport, Head flow.

The present status of knowledge concerning thermally induced transport of moisture in soil was reviewed. This included various theories on proposed mechanisms of thermal moisture transport and experimental data showing the magnitude of moisture flow in various porous materials. Data were chosen to show the relative importance of thermal versus head-type flow. Equations were developed to describe thermally induced moisture flow near the soil surface which arises from transient thermal gradients produced by the diurnal temperature cycle. This cycle, which is very pronounced in arid climates, can play an important part in supplying moisture to desert plants. A practical example of thermally induced moisture flow together with its implications was given. (Blecker-Ariz.)
W69-05691

SOIL INVESTIGATIONS IN ARID REGIONS,
Ye P. Gusenkov, and B. A. Kalachev.

Soviet Soil Science, No 8, pp 871-879, August 1965. 3 fig, 7 tab, 25 ref.

Descriptors: *Saline soils, *Arid climates, *Soil investigations, *Soil classifications, *Salts, Land reclamation, Salinity, Maps, Toxicity, Ions, Chlorides, Carbonates, Sulfates, Sodium, Electrical conductance, Variability, Evaporation.
Identifiers: *U.S.S.R., *Salinization, Anions, Cations, Salinometer.

This article discussed investigation of saline soils in arid climates and how these soils should be managed in order to minimize salinity problems. A thorough study of the dynamics of salts in soil is necessary to develop methods for controlling salinization. Planning of improvement programs for soils of arid regions is governed by the degree and nature of their salinization. The soil map is the main document on which to base predictions on the improvement conditions and recommendations for the most economical and effective control of soil salinization. Since salts differ in toxicity, their maximum permissible concentration in the soil must be determined on the basis of their species composition. (Blecker-Ariz.)
W69-05692

SOIL MOISTURE RESPONSE TO RANGE IMPROVEMENT IN THE NORTHERN GREAT PLAINS,
Agricultural Research Service, Miles City, Mont.
For primary bibliographic entry see Field 02I.
W69-05693

WATER AVAILABILITY AND GRASS ROOT DISTRIBUTION IN SELECTED SOILS,
New Mexico State Univ., University Park. Water Resources Research Inst.
O. F. Bailey.
MS Thesis, New Mexico State University, 1967. 67 p, 5 fig, 13 tab, 64 ref, 3 append. OWRR Project A-004-NMEX.

Descriptors: *Moisture availability, *Root distribution, Caliche, Particle size, Soil-water-plant relationships, Specific retention, Root zone, Hard pan.
Identifiers: Moisture equivalent.

Soils underlain by indurated caliche at depths of 9 to 24 inches store more water for plant use than soils without restrictive layers. The maximum storage of available water from a simulated one inch rain was by a coarse textured soil underlain by caliche at 14 inches. Summer rains of less than one half inch were found ineffective for plant growth. Concentration of black grama (bouteloua eriopoda) roots was greatest in the surface horizon of each of five soils, and was greater in soils underlain by indurated caliche than in soils without restrictive layers. A high correlation (r=0.97) was found between moisture equivalent and percent clay. (Anderson-N Mex)
W69-05759

INFILTRATION STUDIES ON NON-WETTABLE SOILS,
Nevada Univ., Reno. Desert Research Inst.
J. T. Cory, R. J. Morris, and S. B. Hussain.
Center for Water Resources Research, Project Report No. 11, July 1968. 28 p, 7 tab, 2 fig, 22 ref. OWRR Project A-020-NEV.

Descriptors: *Infiltration, Habitats, Molecular structure, *Infiltrometer, Loam, Vegetation, Overland flow, Sediment yield, Erosion control, Moisture content.
Identifiers: *Sierra Nevada, *Non-wettable soils.

This project report is the result of research into infiltration rates on decomposed granitic soils of the eastern Sierra Nevada. Results are presented as two separate papers dealing with preliminary findings of this research which is continuing during FY 68-69. The first paper is concerned with factors restricting infiltration rates on decomposed granitic soils representing soils from both natural unburned habitat and areas subjected to fire. As the organic matter from fired soils causes a significantly greater water repellency effect and a change in molecular composition, it is postulated that the repellent layer formed under these conditions may represent a partially polymeric or silica-organic system. The second paper deals with infiltrometer studies on non-wettable soils on East Sierra Nevada. Infiltration plots were located in pure strands of loam, manzanita, and tobaccobrush with 100% litter cover to test the differences in over land flow and sediment yield among the three cover types. Tests were also made on plots where mat-like pine litter was peeled off leaving bare soil. Experimental results indicate that soil non-wettability is caused by pine litter in this locality, and the compensating importance of litter in physically restraining erosion of soil and increasing moisture holding capacity is emphasized. (Pineolini-Nev)
W69-05760

THE INFLUENCE OF SUBSURFACE ASPHALT BARRIERS ON THE WATER PROPERTIES AND THE PRODUCTIVITY OF SAND SOILS,
Michigan State Univ., East Lansing.
A. E. Erickson, C. M. Hansen, and A. J. M. Smucker.
Pap 35, 9th Int Congr Soil Sci Trans, Vol 1, pp 331-337, 1969. 7 p, 1 fig, 4 tab.

Descriptors: *Sands, Soils, Soil sealants, Soil treatment, *Asphalt, Barriers, Root zone, *Impervious membranes, Productivity, Agriculture, *Crop production, Soil-water-plant relationships, Water conservation, Irrigation, Crops, Retention, Water properties.
Identifiers: Soil moisture storage, Soil moisture movement, Soil water storage, Soil suction, *Asphalt membranes, *Barrier films.

Techniques have been developed for placing a thin continuous asphalt barrier that is impervious to water at various depths in sand soils. This barrier decreases the deep penetration of water and increases the amount of water held in the plant root zone. The optimum depth of the barrier depends on moisture tensions relations of the sand and the normal rooting pattern of crops to be grown. The extent of the barrier is determined by drainage considerations. Field experiments have been conducted with vegetables and field crops (with and without irrigation) in various parts of humid and arid regions of the U S, and with rice and sugar cane in Taiwan. The amount of water held in the root zone can often be doubled. Barriers have greatly increased productivity of sand soils in humid climates. In arid climates, barriers have made economies in water use possible by preventing deep percolation and increasing water retention. These barriers are economically feasible in many areas of the world for high profit crops. With the need for additional land and water, this technique could be valuable in producing more food on unproductive droughty sand soils. (USBR)
W69-05802

CABLE AND CLAMP MODIFICATIONS FOR MODEL 104 MOISTURE PROBES,
Forest Service (USDA), Logan. Intermountain Forest and Range Experiment Station.
For primary bibliographic entry see Field 07B.
W69-05883

INSTALLATION OF SOIL MOISTURE ACCESS TUBES IN ROCKY SOILS,
Forest Service (USDA), Logan, Utah. Intermountain Forest and Range Experiment Station.
For primary bibliographic entry see Field 07B.
W69-05887

A TOOL FOR REPAIRING INSTALLED SOIL MOISTURE ACCESS TUBES,
Forest Service (USDA), Logan, Utah. Intermountain Forest and Range Experiment Station.
For primary bibliographic entry see Field 07B.
W69-05888

THE INFILTRATION COMPONENT OF A PASTORAL EXPERIMENTAL CATCHMENT, PARTS 1 AND 2,
Soil Conservation Authority, Kew (Australia).
F. X. Dunin.
J Hydrol, Vol 7, No 2, pp 121-146, Jan 1969. Total 24 p, 8 fig, 6 tab, 13 ref.

Descriptors: *Surface-groundwater relationships, *Hydrograph analysis, Rainfall-runoff relationships, Rainfall disposition, Infiltration, Recharge, Streamflow, Runoff, Bank storage, Base flow, Water storage, Antecedent precipitation, Demonstration watersheds, Model studies, Water management (Applied).
Identifiers: *Australia, Parwan Experimental Area, Antecedent soil moisture.

A method of hydrographic analysis is proposed for the determination of the average infiltration rate during specified intervals of a surface runoff event. This method uses the continuity equation to follow the disposition of the rainfall during the selected hydrograph intervals, using a measure of the surface detention relations for the catchment under study. The variation of the infiltration rate during the runoff event under analysis was expressed as an inverse exponential relationship between infiltration rate and accumulated soil moisture. Description of infiltration characteristics in this form facilitates the assessment of hydrologic effects of changed land-use. Infiltration characteristics of a series of runoff events were compared as a measure of the efficacy of hydrographic analysis and also to provide a mathematical description of the infiltration component of the experimental catchment. This involved the estimation of soil moisture antecedent to runoff production by an indirect method based on the simulation of runoff production by an indirect method based on the simulation of runoff production. The comparison demonstrated that infiltration characteristics were consistent with either of two relationships derived from hydrographic analysis. The variation of the infiltration performance between these two sets of infiltration characteristics was shown to be seasonal and was attributed to swelling of the colloid fraction of the soil. (Knapp-USGS)
W69-05901

GEOMORPHIC GROUPING OF SOILS IN WATERSHED ENGINEERING,
Agricultural Research Service, Beltsville, Md. Hydrograph Lab.
C. B. England, and H. N. Holtan.
J Hydrol, Vol 7, No 2, pp 217-225, Jan 1969. 9 p, 3 fig, 2 tab, 20 ref.

Descriptors: *Soil properties, *Hydrologic aspects, *Watershed management, Rainfall-runoff relationships, Hydrology, Soil management, Soil classifications, Geomorphology, Topography, Slopes, Infiltration, Soil water movement, Soil profiles, Vegetation, Climates, Land use, Demonstration watersheds.
Identifiers: *Geomorphic soil groupings, Watershed engineering.

Soil properties significant to processes of infiltration, moisture storage, drainage, and the hydraulics of surface flow are related to topographic position. Areal and elevational distributions of soils provide a basis for interpretative grouping of soil mapping units in computations for watershed engineering. Soils on an ARS experimental watershed, grouped by deep upland, shallow hillside, and very deep depositional, were plotted on a coutour map of the watershed surface. The elevational sequences thus obtained are representative of the hydraulic relationships between hydrologic response units in small agricultural watersheds. Profile characteristics, areal distribution, and relative elevation position of the units determine watershed response to storm rainfall. (Knapp-USGS)
W69-05907

THIXOTROPIC AGING OF SYNTHETIC SOIL AGGREGATES,
Minnesota Univ., St. Paul.

G. R. Blake, and R. D. Gilman.
North Central Reg Coop Res Proj NC-56. Sci J Ser Pap No 6815, Minn Agr Exp Sta, St. Paul, 1969. 15 p, 5 fig, 3 tab, 12 ref.OWRR Project No. B-003-MINN.

Descriptors: *Soil aggregates, *Soil stability, *Soil water, Laboratory tests, Soil physical properties, Chemical properties, Physical properties, Soil strength, Soil structure, Clays, Viscosity.
Identifiers: *Thixotropy, Thixotropic soil aggregates.

Increase in relative stability of artificially prepared aggregates held at constant water content followed a pattern analogous to a thixotropic sol-gel transformation and strength aging of packed soil. Aggregates were not perceptibly stable to wet sieving at time of formation. Matrix stability of aggregates increased at a rate dependent on water content at which aggregates were stored, on soil type and on storage temperature. High relative stabilities were commonly attained in 24-48 hr at intermediate water contents and at 25 deg C. Extent of slaking resistance was dependent on aging from time of aggregate formation rather than from time of wetting pulverized soil in preparation for pressing into aggregates. The aging phenomenon was independent of organic matter content and of a viable microflora. Data are compatible with the explanation that orientation of water molecules and associated cation equilibrium, and spontaneous shifting of clay particles to positions of lowered potential energy account for the build-up during aging. (Knapp-USGS)
W69-05908

NUMERICAL MODELING OF UNSATURATED GROUND WATER FLOW,
Kansas Univ., Lawrence.
For primary bibliographic entry see Field 02F.
W69-05918

SOIL WATER MEASUREMENT WITH AN Am-241 Be NEUTRON SOURCE AND AN APPLICATION TO EVAPORIMETRY,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.
C. H. M. Van Bavel, and G. B. Stirk.
J Hydrol, Vol 5, No 1, pp 40-46, Mar 1967. 7 p, 4 fig, 2 tab, 4 ref.

Descriptors: *Soil moisture meters, *Nuclear moisture meters, Neutron absorption, Instrumentation, Nuclear meters, Moisture content, Soil moisture, Soil water, Research and development, Lysimeters.
Identifiers: Neutron probes, Neutron logging.

The use of a 150 mc Am-Be source in an otherwise standard neutron soil water content probe gave several significant advantages. These were elimination of gamma radiation and attendant health hazard, reduction in weight, increased counting rate, and an apparently increased depth resolution. Soil water inventories at one site to a depth of 170 cm could be obtained with a precision of around 0.1 cm of water. A suggestion is made that improved neutron logging be combined with a suction-type percolation lysimeter to obtain short-term amounts of evaporation without weighting mechanism.
W69-05926

A RECORDING FIELD TENSIOMETER WITH RAPID RESPONSE CHARACTERISTICS,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.
K. K. Watson.
J Hydrol, Vol 5, No 1, pp 33-39, Mar 1967. 7 p, 2 fig, 4 ref, 1 append.

Descriptors: *Tensiometers, *Soil moisture meters, Instrumentation, Research and development, Calibrations, Moisture tension, Pore pressure, Moisture content, Soil water, Soil moisture.
Identifiers: Tensiometer-pressure transducer unit.

A self-contained tensiometer-pressure transducer system for field use is described. Its advantages over standard tensiometer-remote transducer installations are more rapid response, ease of recording data, lack of interference of surface temperature effects, and lack of the hydraulic response problems common in valving several tensiometers to a remote transducer. Field calibration is easily accomplished using compressed air. Pressure changes of 0.2 mB are detectable. Response errors are negligible with a time constant of 0.2 sec. The complete specifications of the commercially available transducer used are listed. (Knapp-USGS)
W69-05931

2H. Lakes

THERMAL STRATIFICATION IN LAKES: ANALYTICAL AND LABORATORY STUDIES,
University of Science and Technology, Kumasi (Ghana); and Massachusetts Inst. of Tech., Cambridge. Hydrodynamics Lab.
Jonas M. Dake, and Donald R. F. Harleman.
Water Resources Res, Vol 5, No 2, pp 484-495, Apr 1969. 12 p, 8 fig, 1 tab, 20 ref.

Descriptors: *Thermal stratification, *Lakes, *Mathematical models, *Energy budget, Model studies, Laboratory tests, Diffusion, Conduction, Water temperature, Heat transfer, Evaporation, Turbulence, Mass transfer, Dispersion, Solar radiation.
Identifiers: Thermal stratification model, Lake Tahoe.

Theories are developed for the time dependent vertical temperature distribution in a deep lake during the yearly cycle of solar heating and cooling. A portion of the incoming solar radiation is assumed to be absorbed at the water surface, whereas the remainder is absorbed exponentially beneath the surface. Heat is also conducted downward by molecular diffusion. A heat flux balance at the water surface, which accounts for back radiation and evaporative heat loss, is formulated as a boundary condition. The linear, second-order heat transfer equation is solved by superposition of solutions for the surface absorbed radiation and the internally absorbed radiation. Analytical solutions are given for 3 different assumptions regarding the time dependence of the incoming radiation and the surface heat losses. At certain times, the resulting temperature and density distribution in the epilimnion are unstable. Under these conditions convective mixing and turbulent diffusion are accounted for by generating a surface mixed layer of uniform temperature. The depth of the surface mixed layer is determined by a thermal energy balance. The theory shows good agreement with field observations of temperature distributions in Lake Tahoe. Experiments are performed using artificial insolation (mercury vapor and infrared lamps) on a laboratory tank. It is possible to simulate the development of thermal stratification under laboratory conditions. (Knapp-USGS)
W69-05610

CIRCULATION IN SHALLOW HOMOGENEOUS LAKES,
Cornell Univ., Ithaca, N. Y. Coll. of Engineering; and Puerto Rico Univ., Mayaguez. Engineering and Water Resources Research Inst.
James A. Liggett, and Christos Hadjitheodorou.
Work partially supported by Nat Sci Found Grant. ASCE Proc, J Hydraul Div, Vol 95, No HY2, Pap 6454, pp 609-620, Mar 1969. 12 p, 7 fig, 9 ref, append. Grant GK559 (NSF).

Descriptors: *Lakes, *Water circulation, *Wind pressure, Currents (Water), Mathematical models, Numerical analysis, Topgraphy, Path of pollutants, Coriolis force.
Identifiers: Eddy viscosity, Ekman drift.

The steady state, wind driven circulation of a shallow, homogeneous lake on a rotating earth is studied by means of a solution of the equations of fluid motion. The equations are linearized, dissipation is assumed to result only from bottom friction and a constant eddy viscosity is employed. These approximations assume a shallow lake where a characteristic horizontal dimension is large compared to the maximum depth and the depth is of the order of magnitude of the Ekman 'depth of frictional influence'. The solution gives the 3-dimensional circulation patterns for a lake of arbitrary plan form and bottom topography. The effect of bottom topography is shown in sample calculations. (Knapp-USGS)
W69-05618

ABSORPTION COEFFICIENTS OF CHLOROPHYLL DERIVATIVES,
Queen's Univ., Kingston (Ontario). Dept. of Biology.
Seward R. Brown.
J Fish Res Board, Can, Vol 25, No 3, pp 523-540, 1968. 7 fig, 2 tab, 26 ref.

Descriptors: *Chlorophyll, *Diagenesis, *Optical properties, *Plant pigments, *Spectrophotometry, Analytical techniques, Biochemistry, Chemical degradation, Chlorella, Chromatography, Lakes, Limnology, Pigments, Sedimentation.
Identifiers: *Absorption coefficients, *Chlorophyll derivatives, *Molar absorption coefficients, Experimental limnology.

Availability of molar absorption coeffcients is crucial to quantitative spectrophotometric determination of derivatives of chlorophyll in studies of its diagenesis in lacustrine sediments. Author fed radiocarbon dioxide to cultures of Chlorella, heat-killed cells after nine days' growth, extracted pigments, and isolated chlorophyll-a and -b chromatographically. Regression on absorbance at 667 nanometers of counts per minute for solutions of radioactive pheophorbide-a prepared chemically from chlorophyll so isolated and concentrations in milligrams of carbon per liter of crystalline pheophorbide resulted in plots which were statistically similar, thus permitting calculation of concentrations of all derivatives from knowledge of specific activities and molecular weights. Labelled compounds, with molar absorption coefficients in thousands of square centimeters per mole indicated in parentheses (first figure, at wavelength of red maximum; second, at blue) are: chlorophyll-a (135.8, 100.7); allomerised chlorophyll-a (166.5, 86.5); chlorophyllide-a (80.6, 54.2); pheophytin-a (135.6, 66.8); allomerised pheophytin-a (171.2, 69.1); pheophorbide-a (83.9, 41.6); methyl pheophorbide-a (82.0, 39.7); chlorophyll-b (200.9, 72.5); chlorophyllide-b (99.0, 32.9); allomerised chlorophyllide-b (128.8, 31.5); methyl chlorophyllide-b (117.3, 39.5); allomerised methyl chlorophyllide-b (170.9, 34.5); pheophorbide-b (151.9, 31.6); allomerised pheophorbide-b (177.9, 29.8). (Eichhorn-Wis.)
W69-05695

NATURAL AND ARTIFICIALLY (AIR-PLOUGHING) INDUCED MOVEMENT OF RADIOACTIVE PHOSPHORUS FROM THE MUDS OF LAKES,
Wisconsin Univ., Madison. Dept. of Zoology.
A. D. Hasler.
UNESCO Int Conf Radioisotopes, Vol IV, pp 658-675, 1957. 2 fig, 9 tab, disc, 16 ref.

Descriptors: *Lakes, *Mud, *Phosphorus radioisotopes, *Water circulation, Cycling nutrients, Phosphorus compounds, Phosphates, Eutrophication, Diffusion, Water chemistry, Sediment-water interface, Lime, Limnology, Thermal stratification, Aeration.
Identifiers: *Experimental limnology, Lake Peter (Wis), Lake Paul (Wis), Sawmill Pond (Wis), Fish production, Alkalization.

Lakes are wasteful of the phosphorus entering them. Therefore intrafertilization procedures hold promise toward increasing the production of fish. In an undisturbed mud-water system, the percentage, as well as the amount of phosphorus which is

released to the superimposed water, is very small. When radiophosphorus is placed at various depths in the mud the diffusion into the overlying noncirculating water is negligible if placed deeper than 1 cm in the mud. Application of lime to the water, or to the mud, reduces the amount of soluble phosphorus available. Acidification of previously alkalized mud will, upon agitation, increase the amount of phosphorus entering solution. In an aquarium experiment, circulation of the water above phosphorus-rich mud with the aid of air bubbles increases the phosphorus in solution. Thermally stratified lakes can be synthetically circulated by compressed air bubbles for the purpose of fertilizing the surface water. An example is given where a small lake was completely aerated with an effort of 2.4 horsepower hours per kg of oxygen added. These studies demonstrate that lakes can be utilized as experimental models for oceanographic and isotope studies. (Hasler-Wis)
W69-05698

LAKE SEDIMENTS: THE BOTTOM DEPOSITS OF THE NORTH BASIN OF WINDERMERE, WITH SPECIAL REFERENCE TO THE DIATOM SUCCESSION,
Freshwater Biological Association, Ambleside (England).
Winifred Pennington.
New Phytologist, Vol 42, No 1, pp 1-27, May 1943. 10 fig, 35 ref.

Descriptors: *Diatoms, *Cores, *Paleolimnology, Sediments, Eutrophication, Ecology, Paleoecology, Limnology.
Identifiers: *Lake Windermere, English Lake District, Asterionella, Diatoma, Lake evolution, Lake succession, Gomphonema, Melosira, Organic content of cores, England, Pollen analysis, Laminated clay.

Diatom vertical succession was studied on cores from glacial Lake Windermere, English Lake District. In cores examined, four main types of sediment found were: laminated clay; narrow clay bands; brown mud; surface ooze. Results show that earliest deposits in lake basin, ie, laminated clay, contained practically no organic matter and no remains of living organisms. Deposits between top of laminated clay and topmost narrow clay band indicate second period. Changes in lake's environment seem most marked for this period. Large diatoms, notably Melosira, are present throughout zone, but these disappear or decrease abruptly at level of topmost clay band. After deposition of diatomaceous sediment began, ie, when organic production started, sediment's organic content increased progressively. Uniform brown diatomaceous detritus mud represents lake's third period. Large diatoms that characterized lower deposits are rare or absent, replaced by Gomphonema and Pinnularia. Deposit appears to indicate long period of equilibrium conditions after end of glacial influence. Lake's latest period is represented by 20 cm of surface ooze containing abundant Asterionella. Factor causing change was probably increasing dissolved salts caused by sewage pollution following human settlement on lake's shores. Tentative time scale based on sedimentation rates, varve counts, and pollen data is given. (Bortelson-Wis)
W69-05707

A PRELIMINARY REPORT OF THE FOSSIL DIATOM FLORA FROM LAKE HURON SEDIMENTS,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
E. F. Stoermer, and J. J. Yang.
Supported by FWPCA. Proc 11th Conf Great Lakes Res, Vol 11, pp 253-267, Apr 1968. 15 p, 4 fig, 1 tab, 37 ref.

Descriptors: *Diatoms, *Lake Huron, Paleolimnology, Quaternary period.
Identifiers: *Species diversity, Microfossils.

This paper reports floristic analysis of subfossil diatom remains recovered from bottom sediments taken in a core from 45 deg 01.0 min N, 82 deg 01.0 w, Lake Huron. Thirteen 1 ccm samples, spaced at 15 cm intervals, were taken from a 1.8 m core. Examination of standard subsamples in microscopic preparations revealed a total of 187 discernable taxonomic entities. Of these, 160 have been referred to recognized taxa. Considering the location of the sampling area, an unexpectedly high proportion of the taxa find their primary habitat in biocoenoses other than the plankton. There is a tendency for the number of specimens recovered per sample to decrease with depth in the section, although there is considerable variation between samples throughout its length. On the basis of fluctuations in diversity of the flora, it appears that a major disturbance is recorded in the 135 cm sample. On the basis of shifts in relative abundance of the dominant plankton species and their known autecology, it appears that the disturbance represents a return to relatively lower mineral nutrient levels. It is postulated that this event is correlated with the Nipissing Stage of Lake Huron. It appears that either raising or lowering nutrient levels may affect diatom diversity hence diversity estimates alone prove misleading.
W69-05762

NEARSHORE PHYTOPLANKTON POPULATIONS IN THE GRAND HAVEN, MICHIGAN VICINITY DURING THERMAL BAR CONDITIONS,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
E. F. Stoermer.
Proc. 11th Conf. Great Lakes Res., Vol 11, pp 137-150, Apr 1968. 14 p, 13 fig, 1 tab, 17 ref.

Descriptors: *Phytoplankton, *Lake Michigan, *Water circulation, Nuisance algae, Thermal pollution, Diffusion, Diatoms, Chlorophyta, Chrysophyta, Dinoflagellates, Cyanophyta.
Identifiers: *Thermal bar.

In late April 1967, the thermal bar phenomenon had profound effects on both the abundance and species composition of phytoplankton in nearshore Lake Michigan waters in the vicinity of Grand Haven, Michigan. Landward of the thermal bar populations averaged between 1500 and 2000 cells/ml compared with average values of about 400 cells/ml in water entering the lake from the Grand River and about 350 cells/ml in water outside the thermal bar. The highest populations observed, occurred in the interface between inshore and offshore waters. The relative abundance of most species of algae was strikingly dissimilar in the different water masses. Four general types of species distribution were noted: (1) species which were abundant in the harbor flora, rare in the inshore waters, and very rare or lacking in the offshore waters; (2) species which were abundant in the inshore waters, rare in the harbor flora, and rare or lacking in the offshore waters; (3) species which were abundant in the offshore waters, rare in the inshore area and lacking in the harbor flora; (4) species which were most abundant in the interface water with secondary abundance peaks in either of the other habitats. It appears that the primary effect of thermal additions to Lake Michigan is through constraint on circulation which traps nutrients near shore.
W69-05763

DEATH OF A LAKE,
For primary bibliographic entry see Field 05C.
W69-05844

ARTIFICIALLY INDUCED CIRCULATION OF LAKES BY MEANS OF COMPRESSED AIR,
Wisconsin Univ., Madison. Dept. of Zoology.
For primary bibliographic entry see Field 05C.
W69-05866

AVAILABILITY OF IRON AND MANGANESE IN SOUTHERN WISCONSIN LAKES FOR THE GROWTH OF MICROCYSTIS AERUGINOSA,
Wisconsin Univ., Madison. Dept. of Botany.
For primary bibliographic entry see Field 05C.
W69-05867

CELL CONTENTS OF NITROGEN AND PHOSPHORUS AS A MEASURE OF THEIR AVAILABILITY FOR GROWTH OF MICROCYSTIS AERUGINOSA,
Wisconsin Univ., Madison. Dept of Botany.
For primary bibliographic entry see Field 05C.
W69-05868

A COMPARATIVE STUDY IN EUTROPHICATION,
Yale Univ., New Haven, Conn. Osborn Memorial Lab.
For primary bibliographic entry see Field 05C.
W69-05869

MOVEMENTS OF RADIOSODIUM (Na-24) WITHIN AN ICE-COVERED LAKE,
Wisconsin Univ., Madison. Dept. of Zoology.
Gene E. Likens, and Arthur D. Hasler.
Limnology and Oceanography, Vol 7, No 1, pp 48-56, 1962. 9 p, 9 fig, 15 ref.

Descriptors: *Lakes, *Water circulation, Cycling nutrients, Sodium compounds, Diffusion, Water chemistry, Limnology, Wisconsin, Radiochemical analysis, Analytical techniques, Radioecology, Iced lakes, Radioisotopes, Dystrophy, Temperature, Conductivity, Ecosystems.
Identifiers: *Sodium radioisotopes, *Experimental limnology, Tub Lake (Wis), Crushing devices, Scintillation counting, Biological orientation, Winter stagnation.

Radiosodium was transported horizontally a maximum distance of 15-20 meters during the first 24 hours of replicated experiments conducted during January of 1960 and 1961 in a small ice-covered lake in northwestern Wisconsin. Subsequent horizontal displacement was somewhat slower but reached a maximum distance of almost 30 meters from the release point in three days. The dispersed pattern was asymmetrical and different in each of the two experiments. Results indicated that some vertical movement occurred during the experimental periods but was of very low velocity. A crushing device for releasing the radioactive solution in deep water is described. In addition, a 'portable' scintillation counting system was developed for measuring the radioactivity within the lake. (Hasler-Wisc)
W69-05870

PRELIMINARY OBSERVATIONS ON A YEAR'S CYCLE OF SEDIMENTATION IN WINDERMERE, ENGLAND,
For primary bibliographic entry see Field 02J.
W69-05876

QUALITY OF WATER IN SELECTED LAKES OF EASTERN SOUTH DAKOTA,
Geological Survey, Washington, D. C.
L. R. Petri, and L. R. Larson.
S Dak Water Resources Comm Rep of Invest No 1, 1967. 55 p, 3 fig, 7 tab, 7 ref, append.

Descriptors: *Water quality, *Lakes, *South Dakota, Data collections, Evaporation, Algae, Water chemistry, Water utilization, Recreation, Irrigation water, Municipal water, Aquatic bacteria.
Identifiers: Lake water quality.

Significant seasonal changes in water quality were detected from 4 sets of samples taken from 26 lakes from October 1964 to September 1965. Increased concentrations of dissolved solids, sulfate, and other constitutents in February 1965 were caused by ice formation; decreased concentrations resulted from subsequent thawing and spring in-

flow. Dissolved oxygen, which was between 9.4 to 13.4 ppm in all but 3 lakes in October 1964, was virtually absent in 8 lakes and markedly depleted in 9 other lakes in February 1965. In some of the lakes depletion of oxygen was accompanied by increased iron and manganese concentrations. Of 9 common insecticides, 6 were detected in several lakes in May 1965, but only in minute concentrations. Algae were abundant in water from 6 lakes; 79 genera were detected and estimated for population. Water from all lakes is very hard. If softened and treated to remove iron and manganese, water from many of the lakes could be used for municipal supply. Depletion of oxygen and relatively shallow depths severely limit the potential of some of the lakes for fishing and other recreational uses. Water from all but 4 of the lakes is suitable for irrigation on well-drained land. There is no evidence of pollution in any of the lakes. (Knapp-USGS)
W69-05932

2I. Water in Plants

HYDROLOGY, SOIL PROPERTIES, CROP GROWTH AND LAND DRAINAGE,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 02F.
W69-05607

ON THE RELATION BETWEEN TRANSPIRATION, SOIL PHYSICAL PROPERTIES AND CROP PRODUCTION AS A BASIS FOR WATER SUPPLY PLANS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
P. E. Rijtema.
Soil-Water-Plant, Proc and Inform No 15, Comm for Hydrol Res, T. N. O., pp 28-58, 1969. 31 p, 13 fig, 9 tab, 26 ref.

Descriptors: *Soil moisture, *Soils, *Crop response, *Crop production, Moisture availability, Evaporation, Water levels, Permeability, Evapotranspiration, Climates, Water table, Land management, Soil management, Irrigation practices, Irrigation efficiency, Water requirements.
Identifiers: Dry water production.

The effects of climate and soil physical conditions on agricultural crop transpiration and dry matter production are discussed. Evapotranspiration is calculated with a combined meteorological and energy balance approach, using vapor pressure, net radiation, aerodynamic roughness, and wind velocity data. Irrigation requirements are calculated by multiplying free water surface evaporation by an empirical crop coefficient. Crop coefficients may be transferred to other climatic conditions with an empirical equation using albedo and wind data. The relation between water table depth and crop requirements is calculated using capillary conductivity and suction at the lower boundary of the root zone. The relation between dry matter production and transpiration depends on climate and soil fertility may be estimated taking vapor pressure deficit into account. Production is severely affected by severe moisture deficit during heading and early flowering of grains. The drought resistance of soils may be classified by available soil moisture, which depends on soil physical properties. (Knapp-USGS)
W69-05613

SOIL WATER CONTENT IN RELATION TO NUTRIENT UPTAKE BY THE PLANT,
Institute for Soil Fertility, Groningen (Netherlands).
L. K. Wiersum.
Soil-Water-Plant, Proc and Inform No 15, Comm for Hydrol Res, T. N. O., pp 74-89, 1969. 16 p, 3 fig, 56 ref.

Descriptors: *Soil-water-plant relationships, *Soil management, *Nutrient requirements, Crop response, Water levels, Water level fluctuations, Drainage effects, Irrigation effects, Root distribution, Root zone.
Identifiers: Soil water-nutrient mobility relationships.

The relationships of soil moisture content, soil water movement, and nutrient transport are reviewed and recommendations for proper soil water management are made. Movement of nutrients with the flow of water to roots is much more important quantitatively than molecular or diffusion movement. Substances supplied to the vicinity of the root in excess of uptake will accumulate, while substances supplied in deficiency will be depleted, causing a great difference in soil solutions near to and distant from roots. Ions such as phosphate, K, Mn, Fe, and Zn are transported mainly by diffusion. The more mobile nutrients including Ca, Mg, and Na are supplied largely by mass water flow. The continuous presence of available water in the whole root profile is desirable for production of crops. Nutrient loss by leaching is caused by excessive water. Keeping the soils as moist as possible as long as aeration is sufficient for root growth allows the best use of nutrients because of favorable mass flow, diffusion, and root growth conditions. Water level fluctuations should be prevented within reach of roots, which grow downward with low water and are then killed by rising water. Low aeration in saline soils may cause strong increase in sodium uptake, and should be avoided. High moisture content with low aeration could result in increased Mn availability or even in Mn toxicity. (Knapp-USGS)
W69-05615

CALCULATION OF PARAMETERS FOR THE EVALUATION OF THE LEACHING OF SALTS UNDER FIELD CONDITIONS, ILLUSTRATED BY NITRATE,
Institute for Soil Fertility, Groningen (Netherlands).
For primary bibliographic entry see Field 02G.
W69-05616

AERODYNAMIC AND SURFACE FACTORS IN EVAPORATION,
Rothamsted Experimental Station, Harpenden (England); and Munich Univ. (West Germany). Meteorologisches Institut.
G. Szeicz, Gabriella Endrodi, and S. Tajchman.
Water Resources Res, Vol 5, No 2, pp 380-394, Apr 1969. 15 p, 6 fig, 3 tab, 44 ref.

Descriptors: *Evapotranspiration, *Evaporation, *Crops, Energy budget, Diffusion, Advection, Stomata, Winds, Turbulence, Solar radiation.
Identifiers: Eddy conductivity, Roughness (Aerodynamic).

Measurements were made of the roughness length and other aerodynamic qualities of pine forest, lucerne, and potatoes in Germany, and analyzed with additional data obtained from publications. For pliable crops, roughness length decreases by 1/2 for winds of 1-3 m/sec; in this range of winds, roughness length is approximately equal to 1/10 the crop height. Eddy conductivities are about 3 times open-water values for crops and 30 times open-water values for trees. Stomatal diffusion resistance values in trees are alqays 2-4 times as great as in crops, with winds from 1.0-1.5 cm/sec. Energy balance computations give estimates of evaporation for open water, pine forest, potatoes, and lucerne that agree within 5-15% with measurements in England and California. (Knapp-USGS)
W69-05631

PLANT ECOLOGY OF AN ARID BASIN, TRES ALAMOS-REDINGTON AREA, SOUTHEASTERN ARIZONA,
Geological Survey, Washington, D. C.
Robert C. Zimmermann.
Geol Surv Prof Pap 485-D, pp D1-D51, 1969. 51 p, 22 fig, 2 plate, 31 tab, 73 ref.

Descriptors: *Soil-water-plant relationships, *Ecology, *Moisture, *Arid lands, *Arizona, Channels, Hydrologic budget, Non-perennial streams, Perennial streams, Surface runoff, Surface-groundwater relationships, Arizona.
Identifiers: Arid basin plant ecology.

The plant ecology of a 750 sq mi area in the San Pedro Valley of Arizona was studied in relation to the flow regiments of the streams. The average annual rainfall is 12 inches. Streamflow duration ranges from ephemeral to perennial. The vegetation changes from shrubs and cactuses at 3,000 ft altitude to spruce-fir forests at 8,000 ft. In the study area, water tables deeper than 40-50 ft probably do not sustain plant life. This is indicated mainly by the aspect of mesquite, probably the deepest rooting species in the area. Most plants probably have root zones within the top 20-30 ft of the substrate. Most of the valley-floor vegetation in the study area appears to grow independently of regional water tables, as these are in most reaches deeper than 40 ft. The species that seem to require shallow groundwater at least part of the yr are few and probably cover too small an area to affect the regional hydrology. The variations in the vegetation of the San Pedro Valley can be related to easily recognized differences in moisture regimens. Distributions of a few plants may be related to flow events with recurrence intervals of 1 to about 20 years. Variations in the plant cover can thus be explained in terms of current conditions or processes, though the processes may occur either frequently or infrequently. (Knapp-USGS)
W69-05634

THE PHREATOPHYTE PROBLEM IN ARIZONA,
Geological Survey, Tucson, Ariz.; and Bureau of Reclamation, Phoenix, Ariz.
For primary bibliographic entry see Field 03B.
W69-05645

STUDIES ON PRESOWING DROUGHT HARDENING OF WHEAT,
Queensland Wheat Research Inst., Toowoomba (Australia). Primary Industries Dept.
D. R. Woodruff.
Aust J Agric Res, Vol 20, No 1, pp 13-24, Jan 1969. 7 fig, 3 tab, 20 ref.

Descriptors: *Drought resistance, *Wheat, *Seed treatment, *Moisture content, *Crop production, Planting management, Plant physiology, Arid climates, Growth stages, Leaves, Stomata, Moisture stress, Phenology, On-site tests, Greenhouses, Environmental effects, Plant growth, Photoperiodism.
Identifiers: *Presowing, *Australia, *Drought hardening, Relative water content, Parameters.

Results of glasshouse and field experiments designed to study effects of presowing drought hardening treatment on growth, yield, and relative water contents (RWC) of wheat under a wide range of environmental conditions are reported in this paper. The rate at which critical levels of RWC developed during periods of moisture stress was reduced in general by the treatment but not necessarily the final value to which the RWC fell. Grain yield increases due to the hardening treatment varied from 0 to 20% in different experiments. Results were discussed in relation to both cause of observed RWC differences and potential practical role of the technique in arid zone agriculture. (Affleck-Ariz)
W69-05672

STOMATAL OPENING IN ISOLATED EPIDERMAL STRIPS OF VICIA FABA. II. RESPONSES TO KCL CONCENTRATION AND THE ROLE OF POTASSIUM ABSORPTION,
California Univ., Davis. Lab. of Plant-Water Relations.
R. A. Fischer, and Theodore C. Hsiao.
Plant Physiol, Vol 43, pp 1953-1958, 1968. 6 fig, 1 tab, 21 ref.

Descriptors: *Stomata, *Epidermis, *Vetch, *Potassium, *Absorption, Ions, Chlorides, Cytological studies, Tracers, Light, Plant physiology, Plant tissues, Crop response, Carbon dioxide, Air.
Identifiers: Starch.

The stimulation by KCL of stomatal opening in isolated epidermal strips of Vicia faba was examined in this study. The opening response of stomata was maximal at 100 mm KCL in dark plus normal air, while in light plus CO sub 2-free air it was maximal at about 10 mm KCL. CO sub 2-free air was more influential than light in reducing the KCL concentration required for maximal opening. In these processes CL- seemed to be of secondary importance, while K+ was traced with super 86 Rb+ and showed that the increase in stomatal aperture under various conditions was well correlated with K+ uptake. It was suggested that the absorption of extracellular solutes, such as K+, may be the primary mechanism of stomatal opening. The increase in stomatal aperture was also well correlated with the decrease in suitable starch in guard cells under all conditions. This, however, was thought to be a secondary change. (Affleck-Ariz)
W69-05681

AN AGROCLIMATOLOGY SURVEY OF A SEMIARID AREA IN AFRICA SOUTH OF THE SAHARA,
Joint FAO/UNESCO/WMO Interagency Project on Agroclimatology.
J. Cocheme, and P. Franquin.
World Meteorological Organization, Technical Note 86, 136 p, 1967. 67 fig, 33 tab.

Descriptors: *Semiarid climates, *Rainfall, *Crop production, *Climatic data, *Surveys, Agriculture, Soils, Vegetation, Tropical regions, Air circulation, Air temperature, Evaporation, Soil moisture, Moisture availability, Dry seasons, Wet seasons.
Identifiers: *Africa, *Agroclimatology.

An area with a semiarid climate of summer rains in Africa south of the Sahara was delineated and its soils and vegetation briefly described. A simple model of atmospheric circulation illustrated the origins of its tropical climate with a long dry northern winter and summer rains. During the growing season of summer rains, air dryness, temperatures and rates of evaporation were reduced to amounts less likely to impose severe stress on annual crops than those prevailing immediately before and after the rains. Comparisons of yield with climatic factors of rainfall and availability of water periods showed that, where there was a marked relation, the regression tended to be curvilinear, with yield dropping off whenever values of the climatic variables exceeded an optimum range, as well as when they fell short of it. A consideration of the information gathered by the survey and its scale suggested that great caution must be exercised in extrapolating this information to delineate agroclimatic sub-regions for agricultural planning and development. (Blecker-Ariz)
W69-05684

CONSUMPTIVE USE ESTIMATES FROM SOLAR RADIATION AND TEMPERATURE,
Bureau of Reclamation, Denver, Colo.
David C. N. Robb.
Irrig and Drain Specialty Conf, Las Vegas, Nevada, Nov 2-4, 1966, pp 169-191, 12 ref, 6 fig, append.

Descriptors: *Consumptive use, *Evapotranspiration, *Solar radiation, *Air temperature, *Climatic data, Estimating, Data collections, Instrumentation, Irrigation efficiency, Measurement, Water requirements.
Identifiers: *Jensen-Haise method, Short-wave, Crop coefficient.

The Jensen-Haise method for estimating consumptive use from total short-wave solar radiation and mean air temperature shows promise of being a valuable tool for the engineer. Its advantages include simplicity of application and suitability for use in areas unfamiliar to the user. It provides the very real advantage of presenting, in the computed potential evapotranspiration modified by a factor of up to 1.2, a theoretical maximum value of consumptive use under normal climatic conditions. In areas where solar radiation data might be considered inadequate, collection of supplemental solar radiation data, using relatively inexpensive and simple-to-use equipment, should provide enough information to allow transfer of data from other stations with confidence. (Blecker-Ariz.)
W69-05686

AN IMPROVEMENT SCHARDAKOW DYE TECHNIQUE FOR THE MEASUREMENT OF PLANT WATER POTENTIALS,
Central Arid Zone Research Inst., Jodhpur (India).
Man Singh Manohar.
Annals of Arid Zone, Vol 4, No 2, pp 159-163, September 1965, 2 tab, 10 ref.

Descriptors: *Dye releases, *Plant tissues, *Leaves, *Measurement, Plant physiology, Biochemistry, Tracers, Tracking techniques, Analytical techniques.
Identifiers: *Water potential, *Schardakow dye method, Potential, Equilibration.

An improved version of the Schardakow dye technique was described as applied in a study for measurement of the water potential of Ricinus communis leaf. Advantages noted over the original Schardakow dye technique were as follows: (1) Quantity of test material for recording an observation is reduced to a minimum. (2) Necessity of removing the tissue from the test solution for obtaining potential value is avoided. (3) Use of already colored test solution makes it possible to take a series of observations during the equilibration period on the same tissue. The role of plant water potential on physiological and biochemical processes governing quality and quantity of plant growth in an arid climate is important. (Blecker-Ariz.)
W69-05688

MEASUREMENTS OF PRECIPITATION INTERCEPTION BY AN ARID ZONE PLANT COMMUNITY (ACACIA ANEURA F. MUELL),
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Land Research and Regional Survey.
R. O. Slatyer.
UNESCO Arid Zone Research, Vol 25, pp 181-192, 1965, 7 fig, 2 tab, 13 ref, disc.

Descriptors: *Rainfall, *Throughfall, *Interception, *Stemflow, *Measurement, Biological communities, Arid climates, Desert plants, Precipitation (Atmospheric), Canopy, Climatic data, Gages, Microenvironment, Wet seasons, Rainfall intensity.
Identifiers: *Acacia, Australia.

This paper describes measurement techniques and results from a study concerning the fate of rainfall on a desert woodland plant community (Acacia aneura F. Muell) in the Australian arid zone. There was no measureable throughfall until 0.03 in. of area rainfall was received and no measurable stemflow until area rainfall reached 0.01 in. The proportion of area rainfall partitioned into throughfall and stemflow increased rapidly until area rainfall of the order of 0.50 in were reached whereupon subsequent changes were much slower. Throughfall is observed as soon as rain commences (even though it is not measurable immediately) and the first measurable throughfall values are approximately 30%. The proportion of area rainfall partitioned into throughfall and stemflow rose rapidly and it may be assumed that a progressively greater contribution to throughfall was made by water dripping from the wetted surfaces. (Blecker-Ariz.)
W69-05689

ROOT SYSTEM OF FOUR DESERT TREE SPECIES,
Central Arid Zone Research Inst., Jodhpur (India).
C. P. Bhimaya, and R. N. Kaul.
Annals of Arid Zone, Vol 4, No 2, pp 185-194, September 1965, 4 fig, 1 tab, 2 ref.

Descriptors: *Root development, *Root distribution, *Root systems, *Root zone, *Desert plants, Plant physiology, Seeds, Speciation, Trees, Arid lands.
Identifiers: *Transplanting, Tap roots, Shoots.

Trees used in the root study were Tecomella undulata, Prosopis cineraria (Syn. spicigera), Albizia lebbeck and Acacia senegal. The study consisted of two plants from each of the four species, one raised by transplanting and one from seedling. Data collected on each species included shoot length, collar diameter, length of tap root, maximum lateral spread, number of secondary roots, air dry weight of shoot and root, and root to shoot ratio. Compared to the plants from direct seedling the transplanted plants of all tree species exhibited increased length of tap root. The species did not differ markedly in their maximum lateral spread of roots under seeding and transplanting. (Blecker-Ariz.)
W69-05690

SOIL MOISTURE RESPONSE TO RANGE IMPROVEMENT IN THE NORTHERN GREAT PLAINS,
Agricultural Research Service, Miles City, Mont.
Walter R. Houston.
J Range Management, Vol 18, No 1, pp 25-30, January 1965. 4 tab, 21 ref.

Descriptors: *Soil moisture, *Crop production, *Range management, *Moisture stress, *Stocking, Clay loam, Fertilizers, Nitrogen, Semiarid climates, Carrying capacity, Droughts, Range grasses, Montana, Treatment, Great Plains, Soil-water-plant relationships, Precipitation (Atmospheric).
Identifiers: *Pitting.

A study was established to investigate influence of several range improvement practices on soil moisture regimes and soil moisture-herbage production relationships on native semi-arid rangeland in eastern Montana. Range pitting effectively reduced soil moisture stress in the soil profile even during drought. Application of nitrogen fertilizer in the fall reduced soil moisture stress on certain soils. Average soil moisture stress was significantly correlated with several components of herbage production. Many significant interaction effects were evident between different combinations of treatments, years, soils and stocking rates. Interaction effects were observed on both total soil moisture stress and soil moisture stress-herbage production relationships. (Blecker-Ariz.)
W69-05693

2J. Erosion and Sedimentation

SEDIMENT CONTROL METHODS, INTRODUCTION AND WATERSHED AREA,
American Chemical Society, New York. Hydraulics Div.
Vito A. Vanoni.
ASCE Proc, J Hydraul Div, Vol 95, No NY2, pp 649-673, Mar 1969. 25 p, 6 fig, 1 tab, 34 ref.

Descriptors: *Sediment control, *Erosion, *Sedimentation, *Erosion control, Land management, Sediment transport, Water supply, Gully erosion, Mass wasting, Channel improvement, Harbors, Reservoirs, Rivers, Vegetation, Bank protection, Check structures, Contour farming, Diversion structures, Soil management, Terracing.
Identifiers: Sediment control methods.

The varying implications regarding the control of sediments to individuals working in different fields are discussed. The subject is considered in 2 general areas, the land surface and the fluvial channels and associated water bodies. Sediment control on land is discussed in terms of watershed areas, and includes considerations of sheet erosion and rills, gullies, or other small fluvial channels. Larger

channels are discussed separately in terms of natural and artificial channels, since control of the former is restricted generally by its existing form and the design of the latter is permitted many more degrees of freedom. Controls in reservoirs and harbors are treated separately, since the concepts or purposes differ measurably. The prevention of the erosion of sediment particles from the land or from fluvial channels and the controls applicable in fluvial channels or in the lakes, reservoirs, estuaries, or bays into which they flow are also explored. (Knapp-USGS)
W69-05620

THE BEHAVIOR OF LARGE PARTICLES FALLING IN QUIESCENT LIQUIDS,
Geological Survey, Washington, D. C.
G. E. Stringham, D. B. Simons, and H. P. Guy.
Geol Surv Prof Pap 562-C, pp C1-C36, 1969. 36 p, 27 fig, 7 tab, 23 ref.

Descriptors: *Sedimentation, *Settling velocity, *Movement, Particle shape, Particle size, Density, Reynolds number, Turbulence, Sedimentology.
Identifiers: Particle fall behavior, Settling.

The free-fall behavior patterns of specific idealized particles falling singly in quiescent liquids were observed with respect to fall patterns, fall velocity, and travel path. Particle shapes and densities were chosen to represent the limiting conditions of natural gravel-sized sediment found in alluvial channels. The liquids used in the fall column were water, various mixtures of water and glycerine, and pure glycerine. The particles were dropped in a vertical clear plexiglass fall column 3 meters high and 40 cm in diameter. Two 16-mm movie cameras set at right angles to each other and focused on a timer and a 1-meter test section of the column recorded the particle behavior. The spheres usually fell straight, but disks exhibited four types of fall behavior: (1) steady-flat fall when the Reynolds number was less than 100; (2) regular oscillation-oscillation occurred about a diameter perpendicular to the direction of fall, and there was very little horizontal translation; (3) glide-tumble-the frequency of oscillation was less than regular oscillation, the amplitude increased until the disks fell vertically on edge part of the time, and sometimes tumbling occurred at the end of each glide; and (4) tumble-the axis of the fall path was virtually a straight inclined line, the disk continually rotated, and the frequency of rotation approached the frequency of oscillation in the oscillation behavior pattern. The steadiness of a falling particle is dependent upon the stability of the resultant of the pressure forces in the wake of the particle. Extremes in shape and high R cause the resultant force to be the least stable. The more unsteady the particle the greater the path length. (Knapp-USGS)
W69-05625

MATHEMATICAL MODEL AND FORTRAN IV PROGRAM FOR COMPUTER SIMULATION OF DELTAIC SEDIMENTATION,
Stanford Univ., Calif.; and Canterbury Univ., Christchurch (New Zealand).
For primary bibliographic entry see Field 07C.
W69-05657

EVOLUTION OF A DUNED BED UNDER OSCILLATORY FLOW,
Georgia Inst. of Tech., Atlanta. School of Engineering; and Georgia Inst. of Tech., Atlanta. Water Resources Center.
Marion R. Carstens, and Frank M. Neilson.
J Geophys Res, Vol 72, No 12, pp 3053-3059, June 15, 1967. 7 p, 3 fig, 2 tab, 4 ref. DA-49-055-CIVENG-65-1.

Descriptors: *Dunes, *Ripple marks, *Waves (Water), *Hydraulic models, Currents (Water), Beaches, Sedimentation, Erosion, Turbulent flow, Laminar flow.
Identifiers: *Oscillatory water flow.

The evolution of a duned bed from an initially flat bed was observed in a large water tunnel in which water moved over a sand bed with simple harmonic motion. Bed forms were observed to be of two types, (1) rolling-grain and (2) vortex, which are called ripples and dunes, respectively. Ripples are the initial transient bed forms that are replaced by dunes. Ripples formed spontaneously when the water-motion amplitudes by placing an obstruction on the otherwise flat bed. The history of a duned bed was observed and is described from birth to equilibrium. (Knapp-USGA)
W69-05662

AN OPERATIONS RESEARCH APPROACH TO BASIN SEDIMENT CONTROL,
Johns Hopkins Univ., Baltimore, Md.
Erhard F. Joeres.
Proc Third Annu Amer Water Resources Conf, San Francisco, pp 261-273, Nov 1967. 13 p, 3 fig, 18 ref, 1 append.

Descriptors: *Sediment control, *Dynamic programming, River basins, Optimization, Damages, Stochastic processes, Decision making, Deposition (Sediments), Alternative costs, Estuaries, Mathematical models, Reservoir design.

A deterministic dynamic programming model was structured to find the minimum total cost of control measures and damage costs for sedimentation in a hypothetical river basin (a main stem, fed by two tributaries, which discharged into an estuary) assumptions used were: (1) a pre-development equilibrium used for comparison; (2) a post-development fixed sediment load; and (3) decisions for degree of control and damages were independent of size distribution of sediment load. The solution proceeded by finding the optimum return in the tributaries, and then working recursively upstream from estuary in the main stem. The difficulties of handling stochastic variations of the sediment load were discussed. (See also W69-02227). (Gysi-Cornell)
W69-05733

THE DEVELOPMENT, USE AND EFFICIENCY OF INDICES OF SOIL ERODIBILITY,
Alberta Univ., Edmonton.
Rorke B. Bryan.
Geoderma, Vol 2, No 1, pp 5-26, Sept 1968. 22 p, 3 fig, 5 tab, 37 ref.

Descriptors: *Soil erosion, *Erosion, *Indexes, Soil science, Rainfall simulators, Soil aggregates, Soils, Bibliographies, Soil structure, Soil texture, Statistical analysis, Soil physical properties, Silts, Clays, Dispersion.
Identifiers: *Erosion index, Raindrop splash.

Development and use of indices of soil erodibility during the past 30 yr are reviewed. The ambiguous record of some indices is mentioned and a theoretical assessment made of their validity and limitations. Testing index efficiency against a standard reference of soil loss from samples subjected to artificially simulated rainfall is described. The efficiency of each index is measured by statistical analysis. The most efficient indices of soil erodibility are: (1) percentage-weight of water-stable aggregates (WSA) greater than 3 mm, (2) percentage-weight of WSA greater than 0.5 mm, (3) erosion ratio, (4) surface-aggregation ratio, (5) modified surface-aggregation ratio, and (6) clay ratio. Further statistical analysis shows that percentage-weight of WSA greater than 3 mm is the only completely reliable index of erodibility. (USBR)
W69-05826

BEHAVIOR OF MIDDLE LOUP RIVER CHANNEL AS INFLUENCED BY MILBURN DIVERSION DAM.
Bureau of Reclamation, Denver, Colo.
Pap, Sedimentation Br, Div Proj Invest, Bur Reclam, Denver, Colo, May 1968. 35 p, 24 fig, 3 tab.

Descriptors: *Aggradation, *Degradation, *Degradation (Stream), Slope protection, *Sedimentation, Sedimentation rates, Deposition (Sediments), Sediment control, Sediments, *Sediment transport, Stream channels, Stream erosion, Channel erosion, Channel improvement, Channels.
Identifiers: Sediment deposits, Sediment-water relationship, Channel protection, *Milburn Diversion Dam (Nebr).

This report updates aggradation and degradation studies made at Milburn Diversion Dam on the Middle Loup River in central Nebraska. Aggradation above the dam has proceeded at a rate and to an extent beyond original expectations. Approximately 180 acre-ft of sediment per year is being deposited in the aggrading reach. Degradation has reached a depth greater than anticipated and extends at least 3-1/2 mi downstream from the dam. Sediment transport computations indicate an average annual movement of 400 acre-ft of sediment into the depositional area. Bedload transport studies indicate that a channel having a slope of 0.0012 and a width of 100 ft would be capable of transporting the annual sediment through the depositional area. Mechanical removal of the deposited sediment is necessary to initiate and maintain a channel through the depositional area for transporting the sediment load to the dam where it can be sluiced downstream. Controlling the lateral movement of the channel will be a major problem. The banks possibly can be stabilized with car bodies, jacks, riprap, or a combination of these. (USBR)
W69-05841

PRELIMINARY OBSERVATIONS ON A YEAR'S CYCLE OF SEDIMENTATION IN WINDERMERE, ENGLAND,
Winifred Tutin.
Mem Ist Ital Idrobiol, Suppl 8, pp 467-484, 1955. 7 fig, 1 tab, 7 ref.

Descriptors: *Sedimentation, *Sedimentation rate, Diatoms, Lakes, Limnology, Organic matter, Silica.
Identifiers: Lake Windermere, Lake Ennerdale, England, Sediment traps, Annual sedimentation cycle, Asterionella, Diatomaceous silica, Lake deposits.

Amounts of sediment, in milligrams per square meter per week, were collected in cylindrical vessels in Lakes Windermere and Ennerdale. The sediment collected was fractionated into diatom silica, organic content, and mineral silt. In general, variations in quantity of sediment collected were fairly consistent in Windermere at 30 and 60 meters; the vessels at 15 meters sometimes caught more or less. The period of lowest sedimentation was in late summer after the peak organic production had passed. For the rest of the year the sedimentation rate was approximately constant with minor fluctuations. Organic matter was fairly constant throughout the year at 30% of the dry weight. The diatomaceous silica and mineral fraction showed more variation throughout the year, mineral sediment being high in winter and diatomaceous silica showing a steep rise in June when the spring crop of Asterionella began to settle out from the photic zone. The sedimentation rate for the middle of the north basin of Windermere was calculated to be 2.6 millimeters per year. (Bortleson-Wisc)
W69-05876

THE ROLE OF SOME STATISTICAL AND MATHEMATICAL METHODS IN THE INTERPRETATION OF REGIONAL GEOCHEMICAL DATA,
Royal School of Mines, London (England); and Imperial Coll. of Science and Technology, London (England). Dept. of Geology.
Ian Nichol, R. G. Garrett, and J. S. Webb.
Econ Geol, Vol 64, No 2, pp 204-220, Mar-Apr 1969. 17 p, 14 fig, 4 tab, 40 ref.

Descriptors: *Geochemistry, *Sediments, *Streams, *Exploration, Surveys, Statistical methods, Geologic control, Soil analysis, Trace elements, Chemical analysis.
Identifiers: Trend surface analysis, Factor vector analysis, Sierra Leone.

Interpretation of regional geochemical survey data requires consideration of the effects of bedrock geochemistry and the influence of weathering and other secondary factors tending to modify the bedrock-soil-stream sediment relationship. Visual interpretation of complex multi-element data may only serve to recognize the more obvious geochemical patterns leaving subtle though significant features undetected. In the Basement Complex of Sierra Leone, trend surface and rolling mean analysis were used to portray trends in metal distribution and to focus attention on local areas where the data deviate significantly from the trend. Sediment samples were collected over 1,500 sq mi at a density of 4-5 samples per sq mi. Analysis showed variation in distribution of elements with bedrock type. Co, Cr, Mn, Ni, Ti, V and Zn tend to be enriched over areas of basic and ultrabasic rock whereas Ga and Pb are concentrated in granite. A reconnaissance over 15,000 sq mi at a density of 1 sample per 70 sq mi showed marked regional variation in minor elements with rock, soil, and topography. Similarly, in areas of complex geology and geochemistry, factor-vector analysis is applicable as a method of determining and delineating patterns of variation in the trace element composition as a whole which may then be correlated with the geology, secondary environment or some other causal factor. (Knapp-USGS)
W69-05895

FORMATION OF A RIVER MOUTH BAR WHERE MARINE FACTORS PLAY AN IMPORTANT ROLE (EXEMPLIFIED BY THE LIELUPE RIVER),
State Oceanographic Inst., Moscow (USSR).
V. V. Romashin.
Transl from Trudy Gos Okeanogr Inst, No 89, 1967, pp 161-174. Soviet Hydrol, Selec Pap, No 6, pp 649-658, 1967. 10 p, 5 fig, 3 tab, 14 ref.

Descriptors: *Deltas, *Sedimentation, *Beach erosion, Erosion, Coasts, Rivers, Sediment transport, Waves (Water), Currents (Water), Littoral drift, Sedimentary structures.
Identifiers: *Lielupe River (USSR).

The mechanism of reformation of a bar in the mouth of the Lielupe River by frontal (head) waves and accompanying local currents is analyzed. The formation and dynamics of submerged sand ridges are examined as one of the forms of sediment delivery to the shore of a river mouth. Starting in 1959, annual soundings and shore surveys and annual delta, bar, and shore deposit maps were made. In the western part of the bar, erosion is relatively uniform whereas in the eastern and central parts, there is net deposition. In the whole delta system there is net removal of material.
W69-05952

SOME PATTERNS OF FORMATION OF A RIVER MOUTH BAR WHERE RIVER FACTORS PLAY AN IMPORTANT ROLE (EXEMPLIFIED BY THE VISTULA DELTA),
State Oceanographic Institute, Moscow (USSR).
V. N. Mikhaylov.
Trans from Trudy Gos Okeanogr Inst, No 89, pp 175-190. Soviet Hydrol, Selec Pap, No 6, pp 659-671, 1967. 13 p, 4 fig, 4 tab, 16 ref.

Descriptors: *Deltas, *Sand bars, *Coasts, *Currents (Water), Rivers, Sedimentation, Streamflow, Waves (Water), Winds, Coastal structures, Jetties, Shore protection, Littoral drift, Sedimentary structures, Erosion, Beach erosion.
Identifiers: *Vistula River.

The formation of a bar in the Vistula delta near Swibno is used as an example to study the main patterns of river mouth bar development where river factors play the predominant role. It is demonstrated that bar morphology depends on the characteristics of the hydrologic and channel regime of the river. The factors affecting bar morphology are the volume of sediments delivered, the volume of sediments delivered, the volume of sediments moving off the bar, river discharge, longshore drifting, shore configuration, sediment composition, sea floor morphology, ice phenomena, and offshore depth. The total volume of the Vistula bar was 163.5 million cu m in 1953, and an average of 2.5 million cu m were deposited from 1895-1953. The weak longshore drift is west to east. Wave action is weak. Engineering structures and dredging have little success in bar control; the channel fills in weeks or months. (Knapp-USGS)
W69-05953

2K. Chemical Processes

DETERMINATION OF THE GROUND-WATER COMPONENT OF PEAK DISCHARGE FROM THE CHEMISTRY OF TOTAL RUNOFF,
Nova Scotia Dept. of Mines, Halifax.
For primary bibliographic entry see Field 02F.
W69-05628

RATE OF SULFURIC ACID FORMATION IN YELLOWSTONE NATIONAL PARK,
Geological Survey, Menlo Park, Calif.
Robert Schoen.
Geol Soc Amer Bull, Vol 80, No 4, pp 643-650, Apr 1969. 8 p, 2 fig, 1 plate, 2 tab, 16 ref.

Descriptors: *Acidic water, *Hot springs, Water chemistry, Gases, Hydrogen sulfides, Sulfates, Geysers, Aerobic bacteria, Sulfur bacteria, Chemical reactions, Oxidation, Sulfides, Thermal springs, Thermal water, Water quality, Hydrogen ion concentration, Wyoming.
Identifiers: *Yellowstone National Park, Sulfuric acid.

Sulfuric acid forms near sulfurous hot springs as the result of oxidation of hydrogen sulfide exhalations by atmospheric oxygen. This strong acid rapidly alters the surrounding rocks and can destroy man-made structures and contaminate streams. Acid-altered ground in Yellowstone National Park was studied in order to determine the rate at which sulfuric acid is forming. Although the size of the hot-spring areas varied by as much as a factor of 19, acid production was nearly uniform at about 10 g per sq m of area per day. The near constancy of acid production per unit area implies that the area of land surface is a major control of the oxidation reaction of sulfide to sulfate. This is consistent with a biological origin for the acid by aerobic sulfur-oxidizing bacteria living close to the land surface. Laboratory rates of acid production for sulfur-oxidizing bacteria are as much as 200 times greater than the rates measured in Yellowstone National Park. A strictly biological origin for the acid is, therefore, quantitatively feasible. This does not rule out the possibility of the formation of natural sulfuric acid in hot springs by inorganic processes. (Knapp-USGS)
W69-05635

BACTERIAL ORIGIN OF SULFURIC ACID IN SULFUROUS HOT SPRINGS,
Geological Survey, Menlo Park, Calif.
R. Schoen, and Garry G. Ehrlich.
Proc 23rd Int Geol Congr, Vol 17, pp 171-178, 1968. 8 p, 2 fig, 1 tab, 10 ref.

Descriptors: *Sulfur bacteria, *Hot Springs, *Acids, Sulfur compounds, Hydrogen sulfide, Sulfates, Sulfides, Oxidation, Wyoming, Aerobic bacteria, Hydrogen ion concentration.
Identifiers: Thiobacillus thiooxidans, Yellowstone Park, Sulfuric acid, Acid groundwater.

The sulfur-oxidizing bacterium Thiobacillus thiooxidans has been found in abundance in many sulfurous hot-spring areas in the western United States. T. thiooxodans occurs only in samples taken from depths less than 18 cm and at temperatures less than 50 deg C. Hot-spring areas in which hydrogen sulfide, carbon dioxide, and water are constantly supplied from depth and the ground temperature is uniformly warm throughout the year, are ideal places for the prolific growth of T. thiooxidans. The quantity of sulfuric acid that T. thiooxidans can produce in its life processes appears to be adequate to account for the sulfuric acid observed in most acid thermal springs. Although an inorganic mechanism may exist for the natural oxidation of hydrogen sulfide and elemental sulfur to sulfuric acid, its rate is probably so much slower than exhibited by T. thiooxidans as to be quantitatively insignificant. (Knapp-USGS)
W69-05654

DETERMINATION AND ISOTOPE-RATIO ANALYSIS OF DIFFERENT FORMS OF NITROGEN IN SOILS: 6. MINERALIZABLE NITROGEN,
Iowa State Univ., Ames. Dept. of Agronomy.
For primary bibliographic entry see Field 05A.
W69-05699

DETERMINATION AND ISOTOPE-RATIO ANALYSIS OF DIFFERENT FORMS OF NITROGEN IN SOILS: 3. EXCHANGEABLE AMMONIUM, NITRATE, AND NITRITE BY EXTRACTION-DISTILLATION METHODS,
Iowa State Univ., Ames. Dept. of Agronomy.
For primary bibliographic entry see Field 05A.
W69-05700

DETERMINATION AND ISOTOPE-RATIO ANALYSIS OF DIFFERENT FORMS OF NITROGEN IN SOILS: 4. EXCHANGEABLE AMMONIUM, NITRATE, AND NITRITE BY DIRECT-DISTILLATION METHODS,
Iowa State Univ., Ames. Dept. of Agronomy.
For primary bibliographic entry see Field 05A.
W69-05701

CHARACTERIZATION OF MINERALIZABLE NITROGEN IN SOILS,
Iowa State Univ., Ames. Dept. of Agronomy.
For primary bibliographic entry see Field 05A.
W69-05703

STEAM DISTILLATION METHODS FOR DETERMINATION OF AMMONIUM, NITRATE AND NITRITE,
Iowa State Univ., Ames. Dept. of Agronomy.
For primary bibliographic entry see Field 05A.
W69-05709

EFFECT OF CULTIVATION ON THE NITROGEN DISTRIBUTION IN SOILS,
Iowa State Univ., Ames. Dept. of Soils.
D. R. Keeney, and J. M. Bremner.
Soil Sci Soc Amer Proc, Vol 28, No 5, pp 653-656, Sept-Oct 1964.

Descriptors: *Cultivation effects, *Soils, *Nitrogen, *Nitrogen compounds, Nitrogen forms.

The effect of cultivation on 10 soils was studied. Cultivation led to a marked decrease in all forms of nitrogen, except non-exchangeable ammonium-nitrogen. The average percent loss of total nitrogen on cultivation was 36.2%, and the average losses of different forms of nitrogen, based on the percent loss in total nitrogen, decreased in the order: hydrolyzable nitrogen (70.5%) greater than amino acid nitrogen (29.8%) greater than non-hydrolyzable nitrogen (29.5%) greater than unidentified hydrolyzable nitrogen (20.0%) greater than hydrolyzable ammonium-nitrogen (17.1%) greater than hexosamine nitrogen (3.5%) greater than non-exchangeable ammonium-nitrogen (0.5%). The average losses of different forms of nitrogen, based

as a percentage of nitrogen in the virgin soils decreased in the order: amino acid nitrogen (43.0%) greater than non-hydrolyzable nitrogen (39.4%) greater than total nitrogen (36.2%) greater than total hydrolyzable nitrogen (35.2%) greater than unidentified hydrolyzable nitrogen (34.5%) greater than hydrolyzable ammonium-nitrogen (28.6%) greater than hexosamine nitrogen (27.6%) greater than non-exchangeable ammonium-nitrogen (0.2%). The results leave very little doubt that native non-exchangable ammonium-nitrogen is practically unavailable to both plants and microorganisms. (Konrad-Wis)
W69-05710

INORGANIC NITROGEN IN PRECIPITATION AND ATMOSPHERIC SEDIMENTS,
Hamilton Filtration Plant (Ontario).
For primary bibliographic entry see Field 05B.
W69-05712

SIGNIFICANCE OF REDOX POTENTIAL IN NATURAL WATERS (IN FRENCH),
Paris Univ., St. Maur (France). Faculte des Sciences.
G. Michard.
Mineral Deposita, Vol 2, pp 34-36, 1967. 4 p, 1 fig, 12 ref.

Descriptors: *Water chemistry, *Oxidation-reduction potential, *Geochemistry, Aeration, Catalysts, Iron, Manganese, Oxygen, Hydrogen ion concentration, Sulfur.
Identifiers: *Nernst equation.

Comparison of measurements with predictions derived from the Nernst equation revealed an anomaly in behavior of the redox system in aerated natural waters. Consideration of these departures from theory led to the following conclusions: (1) The water-oxygen redox system reacts very slowly near the equilibrium point; (2) all systems containing a very small proportial term, for instance Fe (III)/Fe (II) when Fe (II) is less than 0.00001 M, react very slowly; and (3) measurements at the platinum electrode in slow systems are mixed potentials for which Nernst's law is not applicable. In the case of aerated waters, it is proposed to substitute thermodynamic Eh for the measured value in Eh/pH diagrams. In sulfurated waters, such diagrams should be replaced by a log S/pH diagram, where S is the total amount of S (-II). Based upon these considerations, the redox behavior of manganese is considered in some detail.
W69-05877

SALT ACCUMULATION PROCESSES IN THE GROUND WATERS OF THE KIROVABAD-KAZAKH MASSIF,
Academy of Sciences of the Azerbaijanian, Baku (USSR).
For primary bibliographic entry see Field 02F.
W69-05954

2L. Estuaries

MATHEMATICAL MODEL AND FORTRAN IV PROGRAM FOR COMPUTER SIMULATION OF DELTAIC SEDIMENTATION,
Stanford Univ., Calif.; and Canterbury Univ., Christchurch (New Zealand).
For primary bibliographic entry see Field 07C.
W69-05657

SOME OBSERVATIONS ON THE DEPENDENCE OF ZOOPLANKTON GRAZING ON THE CELL SIZE AND CONCENTRATION OF PHYTOPLANKTON BLOOMS,
Fisherises Research Board of Canada, Nanaimo (British Columbia). Pacific Oceanographic Group.
T. R. Parsons, R. J. LeBrasseur, and J. D. Fulton.
J Oceanogr Soc Japan, Vol 23, No 1, pp 10-17, Feb 1967. 4 fig, 1 tab, 15 ref.

Descriptors: *Biomass, *Grazing, *Phytoplankton, *Zooplankton, Estuaries, Ecosystems, Eutrophication, Nannoplankton, Diatoms, Copepods, Fjords, Growth stages, Feeding rates, Productivity, Particle size.
Identifiers: *Cell size, Biological oceanography, Flagellates, Chaetoceros socialis, Chaetoceros debilis, Calanus pacificus, Euphausia pacifica, Pseudocalanus minutus.

Furcilia, Coulter counter, Ivlev's relationship, Particulates, Saanich Inlet, British Columbia. Authors determined, with Coulter counter (apertures: 100 and 400 microns), size and quantity of particulate food consumed by different zooplankters during occurrence of two natural phytoplankton blooms. Individual organisms constituting Chaetoceros bloom could be readily utilized by Euphausia pacifica (EP); but Calanus pacificus (CP), euphausiid furcilia (EF), and Pseudocalanus minutus (PM) could derive only a subsistence diet from same plants. Unidentified nannoplankters, about 8 microns diameter, were less available as food for EP but a better food source for CP and EF. Authors suggest that differences may relate to food's physical availability in terms of its size and shape. Data relating zooplanktonic feeding at various phytoplanktonic concentrations could be described by following modification of relationship originally proposed by Ivlev: r= R (1 - (exp (-kp)) (exp (-kp-sub-0))), where r= ration, p= food density, R= maximum ration, k= proportionality constant, and p-sub-0= low prey density at which feeding ceased. In experiments described, rations as carbon (percentage body weight) were: (mean food size, 32 microns) PM, 0.8; EP, 15.0; CP+ EF, 2.0; (mean food size, 8 microns) CP+ EF, 4.1. EP food above subsistence level apparently went into egg production, observable as a distinct size fraction of the particulate biomass during Chaetoceros bloom. (Eichhorn-Wis)
W69-05696

STATE PROGRAMS FOR ESTUARINE AREA CONSERVATION,
North Carolina Univ., Cahpel Hill. Inst. of Government.
Milton S. Heath, Jr.
Report to the North Carolina Estuarine Study Committee, pp 1-25, April 1968. 25 p, 5 ref.

Descriptors: Estuaries, *Conservation, Administrative agencies, Atlantic Coastal Plain, Planning, *North Carolina, *Water law, Water policy, Easements, Condemnation, Judicial decisions, Legal aspects, Legislation, Ownership of beds, Riparian rights, State governments, Landfills, Zoning, Administrative decisions, Dredging, Expenditures.
Identifiers: Corps of Engineers, *Constitutional law.

This work consists of a report to the North Carolina Estuary Study Committee on state programs for estuarine area conservation. The first part of the report deals with existing North Carolina programs and laws. Present state programs and their legislative authorization are dealt with generally, and provisions for fill easements for riparian owners, permits for work on navigable waters, registration of dredging equipment, present state ownership of estuarine areas, and marshland construction are discussed. Legal aspects of the ownership, management and use of estuarine areas are analyzed, concentrating on constitutional issues involved in state regulation. The second part sets forth the experience of various other states as to types of regulation of estuarine areas, the agencies involved, planning, court tests, and inter-agency coordination. This is preceeded by a general summary of the practice of these states. (Patterson-Fla)
W69-05776

COMPUTER SIMULATION OF ESTUARIAL NETWORKS,
California Univ., Berkeley; Public Health Service, San Francisco, Calif.; and Water Resources Engineers, Inc., Lafayette, Calif.
Robert P. Shubinski, James C. McCarty, and Marvin R. Lindorf.
Proc, Amer Soc Civil Eng, Vol 91, No HY5, pp 33-49, Sept 1965. 17 p, 6 fig, 15 ref, 1 append.

Descriptors: *Simulation analysis, *Digital computers, *Estuaries, *Deltas, *Hydraulic properties, Input-output analysis, Hydraulic systems, Mathematical model, Water quality control, Tidal effects, Velocity, Water levels, Discharge (Water), Spatial distribution, Temporal distribution.
Identifiers: Sacramento-San Joaquin Delta.

A predictive water quality mathematical model was developed that characterized the dynamic tidal estuary conditions in the Sacramento-San Joaquin River Delta network of California. The basic hydraulic conditions of surface water inflow, Delta consumptive uses, export demands, outflow, and tidal action were used as inputs to the model. A high speed digital computer program was described that would treat up to 1000 channel reaches interconnected at up to 750 junctions. Output gave values for input conditions, total head, velocity, surface width, and flow at selected points in both space and time. Limitations of the procedure were discussed and plans for the development of a dynamic water quality program were considered. (Gysi-Cornell)
W69-05861

FOOD AND FEEDING HABITS OF JUVENILE COHO SALMON AND STEELHEAD TROUT IN WORTHY CREEK, WASHINGTON,
Washington Univ., Seattle. Fisheries Research Inst.
James M. Johnston.
M.A. Thesis, University of Washington, 1967. 77 p, 16 tab, 24 fig, 13 ref. See Vol 2, No 8, W 69-03190. OWRR Project B-004-WASH.

Descriptors: Salmon, *Fish diets, *Aquatic environment, Fish behavior, Fish management, Washington, Fish food organisms, Fish migration.
Identifiers: *Coho salmon, *Steelhead trout, Worthy Creek (Washington), Fish macrohabitat, Fish microhabitat.

Results from stomach analyses of 421 (Oncorhynchus kisutch) collected from six diverse ecological habitats and 155 steelhead trout sampled from three of these habitats from April, 1966, to March, 1967, indicated that the influences of macrohabitat on diet were minor. With the exception of Ephemeroptera nymphs, no significant difference (95% confidence level) was found among the stomach contents of coho taken from four areas. F tests were used to determine any significant differences in the diet of coho in time as well as space during the sampling period. Diptera larvae, Diptera adults, Ephemeroptera nymps, Tricoptera larvae, Homoptera adults, and Aquatic Annelida were found in significantly different amounts in time at the 95% level of confidence. Statistical analysis of the steelhead diet in two of these areas indicated there was no significant difference between these areas for any food organism. Only Diptera adults, Plecoptera nymphs, and aquatic Annelid showed a statistical significance for any monthly differences. Coho occupy microhabitat positions near the water surface in areas of low stream velocity. Steelhead were associated with the substrate regardless of the water velocity. In both species the subsurface foods (immature aquatic-life phases) constituted the greatest volume of the diets, although coho and steelhead in the same macrohabitat had a tendency to feed more on surface foods than did steelhead, and steelhead fed more on the bottom foods.
W69-05890

A CHANGE OF GROUNDWATER REGIME AS A METHOD OF CONTROLLING THE INCURSIONS OF SEA WATER (RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
For primary bibliographic entry see Field 04B.
W69-05939

03. WATER SUPPLY AUGMENTATION AND CONSERVATION

3B. Water Yield Improvement

RELATION OF WATER LOSS TO MOISTURE CONTENT OF HYDROPHYTES IN A NATURAL POND,
Geological Survey, Denver, Colo.
For primary bibliographic entry see Field 02D.
W69-05622

PRELIMINARY WATER YIELDS AFTER TIMBER HARVEST ON CASTLE CREEK, ARIZONA WATERSHEDS,
Arizona Univ., Tucson. Rocky Mountain Forest and Range Experiment Station.
Lowell R. Rich.
Proc 12th Annu Ariz Watershed Symp, Sept 18, 1968, Tempe, Ariz, pp 9-12, 1968. 4 p, 3 fig, 1 photo, 1 tab, 2 ref.

Descriptors: *Water yield improvement, *Watershed management, *Clear-cutting, *Arizona, Cutting management, Forest management, Water conservation, Demonstration watersheds, Water yield, Runoff, Small watersheds.
Identifiers: Gila River watershed, Castle Creek (Ariz).

Water yields after timber harvesting were studied on 2 small watersheds of 900 and 1,163 acre-ft in the Apache National Forest, Arizona. Elevations vary from 7,835 to 8,580 ft. Topography is relatively flat with average slopes of 12%. The average temperature is 43.3 deg F with 250 days below 32 deg and 15 days below 0 deg. Water yields are measured with V-notch weirs. Annual precipitation averages 26.6 in; 53% of the precipitation occurs between October and June. Streamflow averages 2.4 in. annually from the 900 acre watershed and 3.2 from the 1,163 acre watershed. Timber harvesting started in June 1965 and ended in September 1967. Water yields increased by 1/3 in. in a total yield of 1 in. in 1967, and by 1 in. in a total yield of 7 in. in 1968. Covariance analysis indicated a statistical significance (F=8.7). (Knapp-USGS)
W69-05642

WATERSHED PLANNING,
Forest Service (USDA), Tempe, Ariz. Forest Hydrological Lab.
Joseph F. Arnold.
Proc 12th Annu Ariz Watershed Symp, Sept 18, 1968. Tempe, Ariz, pp 13-19, 1968. 7 p, 6 fig, 2 tab, 7 ref.

Descriptors: *Watershed management, *Water yield improvement, Planning, Forest management, Water conservation, Demonstration watersheds, Runoff, Arizona.
Identifiers: Runoff improvement, Watershed planning.

The methods of planning watershed research, development, and use by the U. S. Forest Service are reviewed with emphasis on the study of the hydrologic aspects of vegetation. Soils and parent rocks are studied in pits, road cuts, stream channels, and by portable seismic equipment, as well as analyses of samples in the laboratory. Densities and compositions of plant communities are studied and mapped. Water yields may be improved by changing deeply rooted woody species to shallow-rooted grasses and forbs, reducing interception and transpiration losses. Precipitation, streamflow, temperatures, wind, and solar radiation are recorded. Groundwater and water quality data are collected. Areas of similar vegetation, soils, geology, and hydrologic character are called water management units and will show similar response to treatment. Fire is often used to change the vegetation type, but herbicides are usually necessary to control fast-growing woody species that compete with grasses. (Knapp-USGS)
W69-05643

SANTA YNEZ BAROMETER WATERSHED,
Los Padres National Forest, Santa Barbara, Calif.
William H. Hansen.
Proc 12th Annu Ariz Watershed Symp, Sept 18, 1968, Tempe, Ariz, pp 20-24, 1968. 5 p, 2 photo.

Descriptors: *Watershed management, *Water yield improvement, *Planning, Forest management, Water conservation, Demonstration watersheds, Water yield, Runoff, California.
Identifiers: *Barometer watersheds, Experimental watersheds, Santa Ynez watershed (Cal).

The Santa Ynez watershed, southern California, is studied as a 'barometer watershed' in the measurement and determination of the effect of wildland management on water yields, to assess the benefits of land management for soil and water improvements, and to collect data for use in areas of similar climate and physiography. Solar radiation, wind, dewpoint, and precipitation data are collected at a climatic station. Streamflow and sediment data are collected at a weir. A hydrologic survey estimates that conversion of 35,000 acre-ft to grass will save 5,600 acre-ft of water per yr. Criteria for treatment are: sites must have C soil horizons deeper than the depth of root penetration by replacement vegetation; areas to be worked by machines must have slopes less than 30%; dense stands of water-consuming brush (30%canopy or more); and sites must have a fair potential for grass production. The barometer watershed was divided into 4 types of areas: riparian-phreatophyte, which will yield 1 acre-ft increase per treated acre; riparian-brush, with a 1/2 acre-ft increase; lower chaparral, with a 1/4 acre-ft increase; and upper chaparral, with a 1/2 acre-ft increase. Recreational value is expected to increase with treatment because of improvement of fish habitat. (Knapp-USGS)
W69-05644

THE PHREATOPHYTE PROBLEM IN ARIZONA,
Geological Survey, Tucson, Ariz.; and Bureau of Reclamation, Phoenix, Ariz.
H. M. Babcock, and C. A. Pugh.
Proc 12th Annu Ariz Watershed Symp, Sept 18, 1968, Tempe, Ariz, pp 34-38, 1968. 5 p, 3 photo, 1 tab, 2 ref.

Descriptors: *Phreatophytes, *Consumptive use, Water management (Applied), Evapotranspiration, Riparian plants, Water loss, Water yield improvement.
Identifiers: *Central Arizona Project.

The problems of water consumption by phreatophytes in the Southwestern U. S. are reviewed. About 25 million acre-ft of water are consumed by phreatophytes per year, or about twice the flow of the Colorado River. By 1964, 30 government agencies were working in phreatophyte research. The most effective way to salvage water is probably to lower the water table below the root depth level, which kills the plants. Land clearing permits crops to be grown in place of phreatophytes. The Lower Colorado River water salvage program consists of a channelization project, regulating reservoirs, a groundwater recovery program, and a phreatophyte removal program, all of which are opposed by wildlife and recreation interests. Phreatophyte control may save water at the cost of wildlife, recreational, scenic, and various intangible benefits. (Knapp-USGS)
W69-05645

CREATING HYDROPHOBIC SOIL FOR WATER HARVESTING,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.
Lloyd E. Myers, and Gary W. Frasier.
J Irrig and Drain Div, ASCE, Vol 95, No IR1, Proc Paper 6436, pp 43-54, Mar 1969, 1 fig, 2 tab, 10 ref.

Descriptors: *Water harvesting, *Soil surfaces, *Feasibility studies, *Chemical reactions, *Repellents, Economic feasibility, Soil stabilization, Rainfall-runoff relationships, Erosion control, Chemical analysis, Runoff, Spraying, Application methods, Water yield improvement.
Identifiers: *Hydrophobic soils.

Investigations were conducted to determine feasibility of increasing precipitation runoff from soil surfaces by spraying them with chemicals that cause the soil to become hydrophobic. Five different types of chemicals were evaluated and their performance characteristics were described. One chemical, sodium methyl silanolate, proved suitable for field application and produced 94% runoff from a field plot of sandy loam soil for 5 months after application. Runoff from a 0.04 in. rain falling on dry soil was 60%. Erosion of the hydrophobic soil surface reduced runoff to 76% during the following year. Results indicated that water-repellent chemicals, in combination with soil stabilizers, have potential value for construction of efficient, low cost harvesting catchments. (Affleck-Ariz)
W69-05676

ATTACK ON CUMULUS CLOUDS BY MAN-MADE VERTICAL ASCENDING CURRENTS,
N. I. Vulfson, and A. V. Kondratova.
Meteorol i Gidrol, No 9, pp 22-27, 1968. Transl from Russ, Joint Publ Res Serv Transl 47001, pp 26-33, Dec 1968. 8 p, 4 fig, 2 tab, 4 ref.

Descriptors: Artificial precipitation, Clouds, *Convection, Cloud cover, *Cumulus clouds, Precipitation (Atmospheric), Experimental data, *Weather modification, Wind velocity, Foreign research, *Meteorology, *Cloud physics, Cloud seeding.
Identifiers: Artificially induced nucleation, *Cloud modification, Cloud-droplet samplers, Convective clouds, USSR, Cumulonimbus clouds.

The possibilities of stimulating development of intramass cumulus clouds by artificially created vertical ascending air currents are discussed. Parameters of an installation, based on using turbo-jet motors for creating vertical streams of heated air, are given. Results of preliminary experiments under natural conditions on influencing convective clouds by these hot air streams are discussed. Forming induced clouds is much easier when highly active condensation nuclei were used. However, such clouds had an inferior vertical development, apparently due to their greater stability. Two measurements of the microstructure of these clouds showed a greater concentration of finer droplets than in clouds forming without the introduction of additional nuclei. (USBR)
W69-05821

THE EFFECTS OF WAVES ON EVAPORATION FROM A FREE WATER SURFACE,
Cornell Aeronautical Lab. Inc., Buffalo, N. Y.
For primary bibliographic entry see Field 02D.
W69-05840

3C. Use of Water of Impaired Quality

EVAPORATIVE COOLING OF HEATED IRRIGATION WATER BY SPRINKLER APPLICATION,
Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
J. F. Cline, M. A. Wolf, and F. P. Hungate.
Water Resources Res, Vol 5, No 2, pp 401-406, Apr 1969. 6 p, 1 fig, 3 tab, 20 ref.

Descriptors: *Sprinkler irrigation, *Heated water, *Water reuse, *Cooling water, Water temperature, Thermal power, Thermal pollution, Evaporation, Irrigation, Sprinkling, Waste water disposal.

Identifiers: Heated irrigation water, Evaporative cooling.

Heated water was cooled rapidly to impact temperatures that produce optimum growth in plants by applying the water with a standard irrigation sprinkler. Maximum cooling was observed nearest the sprinkler, where the smallest droplets were measured, and temperatures and mean diameters generally increased with distance from the source. Impact temperatures of the water droplets approached but did not reach wet bulb temperatures. Water as hot as 50 deg C was cooled to droplet temperatures of 25 deg C or less when the sprinklers were operated in an associated arid climate and at line pressures greater than 25 psi. A theoretical treatment correlated well with one selected set of experimental data and with predicted cooling rates for specified droplets in several typical atmospheric conditions and one untypical condition for an arid climate. Only under the condition of high relative humidity at a given ambient temperature does it appear that cooling might be insufficient to produce usable sprinkler water from 50 deg C supply water for crop production. (Knapp-USGS)
W69-05606

3D. Conservation in Domestic and Municipal Use

AN ANALYSIS OF WATER NEEDS FOR ARID AND SEMI-ARID LANDS,
Texas Technological Coll., Lubbock. Dept. of Civil Engineering; and Texas Technological Coll., Lubbock. Water Resources Center.
For primary bibliographic entry see Field 03E.
W69-05673

3E. Conservation in Industry

AN ANALYSIS OF WATER NEEDS FOR ARID AND SEMI-ARID LANDS,
Texas Technological Coll., Lubbock. Dept. of Civil Engineering; and Texas Technological Coll., Lubbock. Water Resources Center.
Dan M. Wells, and Keith R. Marmion.
Symposium on Increasing Food Prod in Arid Lands, Icasals Pub No 3, Texas Tech Coll, Lubbock, Texas, 1969, pp 19-29. 1 tab, 10 ref.

Descriptors: *Arid lands, *Industrial water, *Beneficial use, *Water values, *Water reuse, Water requirements, Water utilization, Water demand, Water consumption, Semiarid climates, Administration, Municipal water, Agriculture, Cost-benefit theory, Economic feasibility, Water resources development, Water allocation (Policy).

A discussion is given of needs, values, and alternative uses of water in arid and semi-arid lands. It si suggested that water should generally be used for the purpose that will return greatest wealth to the region and that water may be too precious a resource to permit its being used for relatively low-valued agricultural production in arid areas. The possibility of utilizing available water resources for industrial production, municipal use, or recreational use should not be ruled out without thorough study when considering alternative uses of water. Considerations of optimality strongly suggest that industrial development be encouraged in arid areas, if necessary at the expense of agriculture development. It appears, however, that with sound management techniques industrial development can take place in arid areas without serious adverse effects on agricultural production. (Affleck-Ariz)
W69-05673

THE FUTURE AGRICULTURAL USE OF WATER - SOUTHERN HUMID REGION,
Tennessee Valley Authority, Wilson Dam, Ala., Agricultural Development Div.
For primary bibliographic entry see Field 06B.
W69-05738

SOME ECONOMIC ASPECTS OF INDUSTRIAL WATER SUPPLY IN THE SOUTH,
Clemson Univ., S. C.
For primary bibliographic entry see Field 06B.
W69-05739

3F. Conservation in Agriculture

ANALYSIS OF AN EVAPORATION CONTROL SYSTEM ON THE SEA OF GALILEE,
Arizona State Univ, Tempe.
C. O. Reiser.
Water Resources Res, Vol 5, No 2, pp 413-418, Apr 1969. 6 p, 2 fig, 1 tab, 10 ref.

Descriptors: *Evaporation control, *Monomolecular films, Alcohols, Water conservation, Water temperature, Energy budget, Dissolved oxygen, Evaporation, Winds, Waves (Water), Arid lands.
Identifiers: *Israel, Lake Zohar, Sea of Galilee.

Water Planning for Israel is conducting field tests to determine the feasibility of applying long-chain alcohols on the Sea of Galilee for evaporation reduction. Good film covers have been obtained on 280-acre Lake Zohar with winds up to 15 mph, and a spray system is being installed on Lake Kishon to test a larger lake with stronger prevailing winds. Using meteorological data and estimated evaporation rates for the Sea of Galilee, the reduced evaporation when covered with an alcohol film has been calculated from the added film resistence. The iterative solution of an energy balance equating the reduced evaporation energy to increased energy storage, back radiation, and conduction to the atmosphere gave a 40% reduction of the annual evaporation rate of 300 million cu m when applying a film for a 10-month period. The film produces a maximum temperature increase of 5 deg C at the surface. (Knapp-USGS)
W69-05601

EFFECT OF SMALL SURFACE WAVES ON EVAPORATION THROUGH MONOLAYERS,
Maryland Univ., College Park.
For primary bibliographic entry see Field 02D.
W69-05604

EVAPORATIVE COOLING OF HEATED IRRIGATION WATER BY SPRINKLER APPLICATION,
Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
For primary bibliographic entry see Field 03C.
W69-05606

RULES OF TRANSFER OF WATER MANAGEMENT EXPERIENCE, WITH SPECIAL REFERENCE TO THE ASSESSMENT OF DRAINAGE DESIGN CONSTANTS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 04A.
W69-05614

CONTROLLING TRANSPIRATION IN ASPEN WITH PHENYLMERCURIC ACETATE,
Utah State Univ., Logan.
G. E. Hart, J. D. Schultz, and G. B. Coltharp.
Water Resources Res, Vol 5, No 2, pp 407-412, Apr 1969. 6 p, 3 fig, 3 tab, 10 ref.

Descriptors: *Evapotranspiration control, *Transpiration control, Stomata, Water conservation, Forests, Water yield improvement, Watershed management, Forest management, Water management (Applied).
Identifiers: Phenylmercuric acetate, Aspen trees.

A 0.0001 M spray of phenylmercuric acetate was applied by helicopter to part of an aspen stand in northern Utah in June, 1967. The natural fluttering action of the aspen leaves facilitated delivery of the spray to the stomate-bearing underside of the leaves. Nine days after treatment, stomate width on treated trees averaged 2.4 microns as compared with 4.0 microns measured on untreated trees. Heat pulse measurements indicated reduction in daylight sap velocity from 11 cm/hr to 6 cm/hr. Seasonal soil moisture depletion was not significantly affected, although the pattern of water usage was delayed for about 6 weeks on the treated area. (Knapp-USGS)
W69-05627

THE CONTRIBUTION OF RESEARCH TO THE EFFICIENT USE OF WATER IN AGRICULTURE,
Volcani Inst. of Agriculture Research, Bet-Dagan (Israel). Div. of Irrigation.
E. Shmueli.
For the 8 Volume Proceedings, see Vol 2, No 9, Field 06B and W69-03305. Int Conf on Water for Peace, Wash, D C, Vol 3, pp 407-422, 1968. 16 p, 1 fig, 4 tab, 80 ref.

Descriptors: *Irrigation efficiency, *Arid lands, *Irrigation practices, *Soil-water-plant relationships, Farm management, Irrigation programs, Irrigation effects, Irrigation engineering, Land management, Crop production, Experimental farms, Sprinkler irrigation, Water reuse.
Identifiers: *Israel, Agricultural research, Saline water irrigation.

Recently Israel agriculture has shown marked progress in efficient use of water; between 1958 and 1964 the irrigated area increased by 23%, despite the fact that no additional water allocations were made. The added acreage included orchards and irrigated crops in the arid south. Although water application per unit area of irrigated land was reduced, yields continued to rise. These results were made possible by research, irrigation extension work, close cooperation with farmers, and use of sprinklers on about 95% of the country's irrigated land. By the early sixties, research findings concerning field crops were widely applied, and attention was directed to a more intensive study of the consumptive water use of fruit trees, particularly citrus. Recommendations were adopted by the more progressive farms only a year after results of the tests were obtained; within 2-3 years they became standard practice. In the field crops studied, a 20% to 40% reduction of water use was generally achieved without affecting the yield level, and in some cases, the reduction was accompanied by increased yields. In putting the findings of field and laboratory experiments into practice, use was made of plant indicators (especially stomatal aperture), meteorological indicators, and soil indicators. Studies were undertaken to find non-conventional means for reducing water consumption, such as anti-transpirants, growth-retardants, water and nutrient supply by trickle irrigation, and the utilization of water of relatively high salinity. (Knapp-USGS)
W69-05650

AN APPROACH TO ATTACKING HUMAN-SOCIAL PROBLEMS RETARDING IRRIGATION AND AGRICULTURAL DEVELOPMENT IN LATIN AMERICA,
Inter-American Center for the Integral Development of Land and Water Resources.
Stephen L. Brower.
For the 8 Volume Proceedings, see Vol 2, No 9, Field 06B and W69-03305. Int Conf on Water for Peace, Wash, D C, Vol 5, pp 931-938, 1968. 8 p, 10 ref.

Descriptors: *Water resources development, *Social impact, *Education, *Training, Employee relations, Irrigation programs, Social change, Labor, Crop production.
Identifiers: *Latin America, Campesino.

Key human-social factors singly or in combination block or reduce the effectiveness of irrigation development projects in Latin America. As a consequence, the productive capacity of people is reduced and the resource is poorly used. The

problem areas are: (1) Failure to effectively integrate the 'campesino' and his family into the development process in such a way as to help him take the giant step from primative to modern agriculture; (2) institutional patterns and organizational structures do not support and facilitate development projects; (3) knowledge, skill and experience in the management processes are lacking to administer adequately all aspects of a development project. A combined experimental research, demonstration, and training proposal aimed at attacking specific aspects of these three human-social problem areas is proposed. Three proposed projects are identified and elaborated relative to these problem areas. (Vorhis-USGS)
W69-05652

SOIL AND CROP MANAGEMENT FOR MAXIMUM WATER-USE EFFICIENCY ON ARID AND SEMIARID LANDS,
Agricultural Research Service, Bushland, Tex.
J. R. Johnston, and C. E. Van Doren.
International Symposium on Increasing Food Prod in Arid Lands, Icasals Pub, No 3, Texas Tech College, Lubbock, Texas, 1969, pp 91-108. 9 fig, 6 tab, 17 ref.

Descriptors: *Soil management, *Planting management, *Crop production, *Water utilization, *Arid lands, Water harvesting, Semiarid climates, Irrigation efficiency, Precipitation (Atmospheric), Great Plains, Groundwater, Surface waters, Fallowing, Soil water, Water storage, Soil profiles, Furrow systems, Dry farming.

Improved water-use efficiency is essential in achieving the production potential of arid and semiarid environments. This paper deals specifically with problems and opportunities for increased efficiency in using precipitation, surface, and groundwater supplies for crop production in arid climates. Soil water, crop geometry, soil profile physical conditions, plant nutrient availability, efficient use of limited irrigation water, water harvesting and storage were considered and discussed in this paper as important for enhancing production from arid and semi-arid lands. Particular reference was made to the southern Plains of the United States. (Affleck-Ariz)
W69-05669

SALT AND WATER BALANCE, COACHELLA VALLEY, CALIFORNIA,
Agricultural Research Service, Riverside, Calif. Salinity Lab.; and Coachella Valley County Water District, Calif.
For primary bibliographic entry see Field 02G.
W69-05670

SALT BALANCE, IRRIGATION EFFICIENCY, AND DRAINAGE DESIGN,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.
Herman Bouwer.
J Irrig and Drain Div, ASCE, Vol 95, No IR1, Proc paper 6465, pp 153-170, Mar 1969. 4 fig, 3 tab, 27 ref.

Descriptors: *Salt balance, *Salt tolerance, *Irrigation efficiency, *Leaching, *Drainage systems, Irrigation water, Root zone, Equations, Water utilization, Water requirements, Rates of application, Drains, Design, Salts, Crop response, Water table.
Identifiers: *Leaching efficiency, Salt concentration.

A simplified procedure was presented to predict how much irrigation water was necessary, in addition to that for evapotranspiration, to maintain salt balance in the root zone. The key factor in the procedure was the leaching efficiency, which appeared to range from 0.2 for fine-textured soils to 0.6 for coarse-textured soils. Also taken into account were salt tolerance of the crop, salt concentration of the irrigation water and evapotranspiration. The procedure accurately predicted known leaching requirements for salt balance of 3 irrigated regions. In defining irrigation efficiency, distinction was made between efficiency of water utilization and efficiency of water application. In conclusion, it was shown that drainage flow from the root zone decreased with time after an irrigation and that the water table response of a system of parallel drains to this flow could be computed for design of a drainage system to avoid high water tables. (Affleck-Ariz)
W69-05671

PREDICTING EFFECTS OF WATER SHORTAGE ON CROP YIELD,
California Univ., Davis. Dept. of Water Science and Engineering.
J. Ian Stewart, and Robert M. Hagan.
J Irrig and Drain Div, ASCE, Vol 95, No IR1, Proc paper 6443, pp 91-104, Mar 1969. 9 fig, 14 ref.

Descriptors: *Crop production, *Water shortage, *Water utilization, *Water allocation (Policy), *Planning, Evapotranspiration, Alfalfa, Sorghum, Wheat, Soil moisture, Water management, Precipitation (Atmospheric), Irrigation efficiency, Moisture deficit, Water supply, Data collections.

This paper discusses relationships existing between water use, expressed as evapotranspiration, and yields of alfalfa, wheat and grain sorghum. Data, assembled from a number of sources, was used to tentatively formulate water production functions in both absolute and relative forms. A detailed hypothetical example of use of such a function for water allocation and management planning for maximization of wheat production during a water shortage was given. The example showed the disproportionate importance which can be attached to stored soil moisture and in-season precipitation when maximization of total production is the goal. Conclusions were basically that definition of water use-yield relationships can be done for certain crops from experimental data, and that the functions thus produced would greatly assist planners at all levels in making water allocation and management decisions, particularly in situations of water shortage. (Affleck-Ariz)
W69-05674

ECONOMIC IMPACT OF WATER RESOURCE DEVELOPMENT,
North Dakota State Univ., Fargo.
For primary bibliographic entry see Field 06B.
W69-05751

WATER AVAILABILITY AND GRASS ROOT DISTRIBUTION IN SELECTED SOILS,
New Mexico State Univ., University Park. Water Resources Research Inst.
For primary bibliographic entry see Field 02G.
W69-05759

THE INFLUENCE OF SUBSURFACE ASPHALT BARRIERS ON THE WATER PROPERTIES AND THE PRODUCTIVITY OF SAND SOILS,
Michigan State Univ., East Lansing.
For primary bibliographic entry see Field 02G.
W69-05802

AUTOMATION AND SEMI-AUTOMATION OF SURFACE IRRIGATION,
Oklahoma State Univ., Stillwater.
James E. Garton.
Pap, Amer Soc Civ Eng Nat Irrig Drain Spec Conf, Phoenix, Ariz, pp 237-251, Nov 1968. 15 p, 6 fig, 13 ref.

Descriptors: *Automation, *Surface irrigation, Irrigation, *Irrigation systems, *Automatic control, Furrow irrigation, Furrows, Irrigation operation and maintenance, Laterals, Irrigation practices.
Identifiers: Cost savings.

Automated irrigation systems can be designed to eliminate practically all labor. One major weakness is the inability to define precisely the design conditions and how these conditions vary. Present automated systems apply water at a cutback rate for a time period equal to that required for initial furrow wetting. This will not result in as uniform an application along the furrow as would additional time periods of 4 or 5 times the initial wetting time; instead of increasing the labor requirement for cutback irrigation, this system reduces labor approximately 98%, compared to a conventional siphon-tube system. Automation will separate the decision of when to apply irrigation water from reliance on the availability of a labor supply. The more timely irrigations should result in increased yields. Research on the hydraulics of spatially varied flow in irrigation distribution channels has made possible the design of more uniform releases of water into individual furrows. An economic analysis of automated systems indicates that labor savings will pay construction costs of the system in less than their useful life. The degree of automation that can be justified economically depends primarily on the availability and cost of labor. (USBR)
W69-05829

DESIGN OF AN AUTOMATED SURFACE IRRIGATION SYSTEM WITH REUSE SYSTEM,
Nebraska Univ., Lincoln.
Paul E. Fischbach.
Pap, Amer Soc Civ Eng Nat Irrig Drain Spec Conf, Phoenix, Ariz, pp 219-236, Nov 1968. 18 p, 10 fig, 7 ref.

Descriptors: Automatic control, Automation, *Irrigation systems, Field tests, *Irrigation design, *Water reuse, *Surface irrigation, Hydraulic gates and valves, Land forms, Slopes, Furrow irrigation, Pumping plants, Furrows, Irrigation, Tensiometers, Control systems, *Irrigation canals, Gate control.
Identifiers: Reuse.

Design and component features for an automatic surface irrigation system with provision for reuse of runoff water are described. Requirements for the system are: a supply of water available on demand; an enclosed pipe system designed to carry water from the source to the point of release for irrigation; a method of sequencing irrigation sets; control of the water flowing over the land surface; a runoff collection and return system; soil moisture sensing devices that sense the need for water to start and stop the system; and electrical controls. Land forming, row direction, furrow stream size, length of run, and application time are discussed. To test and evaluate the theories propounded, an automatic surface irrigation system with runoff water reuse was operated for 3 seasons at the University of Nebraska field laboratory, Mead, Nebr. The system is described and results are discussed. (USBR)
W69-05830

AUTOMATIC SPRINKLER IRRIGATION AND ITS FUTURE IN THE MIDWEST,
Nebraska Univ., Lincoln.
H. Robert Mulliner.
Pap, Amer Soc Civ Eng Nat Irrig Drain Spec Conf, Phoenix, Ariz, pp 139-159, Nov 1968. 20 p, 10 fig.

Descriptors: *Sprinkler irrigation, *Automatic control, Distribution systems, *Automation, *Irrigation systems, Irrigation, Nebraska, Crop production, Irrigation operation and maintenance, Forecasting, Productivity.
Identifiers: Crop yield.

Automatic sprinkler irrigation has become increasingly popular in the midwest during the last 5 yr. Two factors have contributed to this popularity: (1) high priced, unavailable labor and (2) increasing demands for water. Irrigators are increasing profits by substituting capital invested in automated sprinklers for high priced and, many times, unreliable labor. The demand for water by industry, municipalities, and agriculture is increasing each year. Sprinklers are one of the most efficient

methods for distributing water to cropland. Field operations have been reduced by using the automated sprinkler systems for applying nitrogen fertilizers and certain insecticides and fungicides. In northcentral Nebraska, automatic sprinkler irrigation has increased corn yields on 100 sections of land from 30 bu/acre (with favorable rainfall) to 155 bu/acre. Complete irrigation systems are being amortized in 6 to 8 yr. Maintenance costs have been less than $100/yr over a 10-yr period. In the foreseeable future, 1000 more quarter sections of land will be irrigated with automatic sprinkler irrigation systems in northcentral Nebraska. Various types of sprinkler irrigation equipment and methods of operation are described. (USBR)
W69-05831

DEVELOPMENT OF AUTOMATION ON THE SALT RIVER PROJECT,
Salt River Project, Phoenix, Ariz.
H. Shipley.
Pap, Amer Soc Civ Eng Nat Irrig Drain Spec Conf, Phoenix, Ariz, pp 45-67, Nov 1968. 23 p, 11 fig.

Descriptors: *Automation, *Automatic control, Remote control, Canals, *Irrigation systems, Water delivery, Hydrographs, Distribution systems, Telemetry systems, Telemetry, *Gate control, Gates, *Irrigation canals, Supervisory control (Power), Digital systems, Transducers, Construction costs, Hydraulic gates, Hydraulic gates and valves, Bids.
Identifiers: Salt River Project (Ariz), *Digital transducers, Cost savings.

Installation of a remote supervisory control system for controlling irrigation water releases on the Salt River Project in Arizona is expected to result in a savings of approximately $380,000 annually. Officials of the Salt River Valley Water Users' Association decided to contract for installation of a direct digital transducer control system after a study showed that only 4% of the Association's 120 ditchriders' time was spent in regulating the canal gates to obtain the desired flow. The transducer system will provide control at the headworks, main diversion points, and the pumping booster plant. Cost of the first phase (automating the canal system) is estimated at $1,500,000. Automating the entire canal and lateral system would cost about $2,750,000. (USBR)
W69-05832

REMOTE CONTROL OF IRRIGATION WATER FACILITIES,
Coachella Valley County Water District, Calif.
Lowell O. Weeks, and Keith H. Ainsworth.
Pap, Amer Soc Civ Eng Nat Irrig Drain Spec Conf, Phoenix, Ariz, pp 23-43, Nov 1968. 22 p, 8 fig.

Descriptors: *Remote control, *Irrigation systems, Irrigation, Digital systems, Distribution systems, Telemetry systems, Telemetry, Arid lands, Irrigation districts, Electronic equipment, History, Water conservation, Rehabilitation, Deserts, Check structures, *Control systems, *Irrigation canals, *Gate control.
Identifiers: Coachella Valley (Calif), Coachella Valley Water Dist (Calif), Irrigation Districts (Calif), Analog instruments.

In 1963 the 620,000-acre Coachella Valley County Water District entered into a Rehabilitation and Betterment Contract with the Federal Government for certain improvements to be made in the District's irrigation and drainage system. Within the scope of the work were included the purchase and installation of a supervisory remote control system for all canal check gates, pumping plants, debris screens, and monitoring stations. This system consists of the telemetering equipment, communications system, and electrically operated machinery to perform the desired field operation. The telemetering equipment consists of 4 systems--the main canal and 3 domestic water systems. The communications system tying all telemetering together consists of microwave transmitters with interconnection of a VHF radio on an interrogate basis for the remote sites and a tie-in of local land lines where telephone service is available. At all locations a complete alarm system is provided, sounding an audible alarm and flashing light at the headquarters console when trouble occurs. Cost of the remote control system will be paid in 7 yr through savings of labor and equipment costs. Twenty thousand acre-ft of water were conserved in the first 6 mo of operation. (USBR)
W69-05833

AUTOMATION OF IRRIGATION,
Bureau of Reclamation, Washington, D. C.
Maurice N. Langley.
Pap, Amer Soc Civ Eng Nat Irrig Drain Spec Conf, Phoenix, Ariz, pp 1-21, Nov 1968. 21 p, 5 fig.

Descriptors: *Automation, *Irrigation systems, Electronic equipment, *Automatic control, Scheduling, Telemetry systems, Telemetry, Irrigation operation and maintenance, Wilting point, Soil-water-plant relationships, Soil moisture meters, Tensiometers, Irrigation efficiency, Percolation, Evapotranspiration, Experimental farms, Field capacity, Water users.

If automation of irrigation is to include efficient use and management of water, proper scheduling of irrigation applications as to time and amount is an essential first step. Reliable techniques available for such scheduling have been field tested on a farm-by-farm basis. These techniques must be tested on an entire project basis. Several methods of automating on-farm irrigation systems have been used on a field basis for different crops. Research by private industry, state universities, and Government agencies is refining these methods and developing new methods. Electronic controls are available for remote and supervisory control, telemetering, stream gaging, automatic gate operation, and other forms of project irrigation system automation. All of these steps lend themselves to automatic data processing and, in the case of large irrigation systems, to computer analysis techniques. Implementation is largely dependent on knowledge of the very complex soil-water-plant relationship that makes precise scheduling difficult and the direct evidence that automation is profitable for a farmer and project. Although refinements must be made in existing techniques and equipment, 'irrigation automation' is far more than a dream or cliche. (USBR)
W69-05834

THE VALUE OF WATER FOR IRRIGATION IN THE KANSAS RIVER VALLEY,
Kansas State Univ., Manhattan. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 06B.
W69-05919

04. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control of Water on the Surface

RULES OF TRANSFER OF WATER MANAGEMENT EXPERIENCE, WITH SPECIAL REFERENCE TO THE ASSESSMENT OF DRAINAGE DESIGN CONSTANTS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
W. C. Visser.
Soil-Water-Plant, Proc and Inform No 15, Comm for Hydrol Res, T. N. O., pp 90-149, 1969. 60 p, 28 fig, 12 ref.

Descriptors: *Water management (Applied), *Soil-water-plant relationships, Adoption of practices, Optimization, Drainage systems, Irrigation, Irrigation practices, Land management, Parametric hydrology, Water utilization, Administration, Crop response, Crop production.
Identifiers: Agricultural water management.

Irrigation and drainage management techniques are presented in a form suitable for field and project-design uses. Project design and economic return are influenced most by the accuracy of constants and the methods of reducing available data. Comprehensive planning requires optimizing complicated functions with many unknowns and minimizing the effects of error. A field procedure for solving management problems using only the simpler techniques of soil moisture study, crop yield determination, and mathematical data reduction is presented. Curve-fitting techniques adjustment of constants, and graphic solutions are stressed to improve practicality and reduce dependence on computers. Alternatives are chosen by varying the values of parameters representing processes that may be manipulated in practice. The management technique is based on formulae for plant response, groundwater discharge, evaporation, soil moisture profile, desorption curve, and rainfall frequency. The methods may be used with proper caution, for preliminary management decisions in areas in which insufficient data are available. (Knapp-USGS)
W69-05614

FLOOD PLAIN INFORMATION, ROCK RIVER AT BELOIT, WISCONSIN.
Corps of Engineers, Rock Island, Ill.

Corps Eng Flood Plain Rep, June 1968. 55 p, 28 fig, 13 plate, 11 tab.

Descriptors: *Floods, *Flood damage, Flood plains, Flood control, Non-structural alternatives, Wisconsin, Maximum probable flood, Historic flood.
Identifiers: *Beloit (Wis), Rock River, Standard project flood, Intermediate regional flood.

Flooding of the Rock River, Beloit, Wisconsin is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W69-05646

FLOOD PLAIN INFORMATION, IRWIN, LONG AND PAW CREEKS, CHARLOTTE, NORTH CAROLINA (VOLUME 1).
Corps of Engineers, Charleston, S. C.

Corps Eng Flood Plain Rep, June 1968. 75 p, 24 fig, 33 plate, 14 tab.

Descriptors: *Floods, *Flood damage, Flood plains, Flood control, Non-structural alternatives, North Carolina, Maximum probable flood, Historic flood.
Identifiers: *Charlotte (NC), Long Creek, Paw Creek, Standard project flood, Intermediate regional flood.

Flooding of Irwin, Long, and Paw Creeks, Charlotte, North Carolina is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)

W69-05647

FLOOD PLAIN INFORMATION, FORKED DEER RIVERS, AND LEWIS CREEK, DYERSBURG, TENNESSEE.
Corps of Engineers, Memphis, Tenn.

Corps Eng Flood Plain Rep, Aug 1968. 86 p, 10 fig, 29 plate, 21 tab.

Descriptors: *Floods, *Flood damage, Flood plains, Flood control, Non-structural alternatives, Tennessee, Maximum probable flood, Historic flood.
Identifiers: *Dyersburg (Tenn), Forked Deer River, Lewis Creek, Standard project flood, Intermediate regional flood.

Flooding of the Forked Deer Rivers and Lewis Creek, Dyersburg, Tennesse is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W69-05648

FLOOD PLAIN INFORMATION, CHEHALIS AND SKOOKUMCHUCK RIVERS, CENTRALIA-CHEHALIS, WASHINGTON.
Corps of Engineers, Seattle, Wash.

Corps Eng Flood Plain Rep, June 1968. 47 p, 11 fig, 16 plate, 13 tab.

Descriptors: *Floods, *Flood damage, Flood plains, Flood control, Non-structural alternatives, Washington, Maximum probable flood, Historic flood.
Identifiers: *Centralia (Wash), Chehalis, Chehalis River, Skookumchuck River, Standard project flood, Intermediate regional flood.

Flooding of the Chehalis and Skookumchuck Rivers, Centralia and Chehalis, Washington is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W69-05649

THE CONTRIBUTION OF RESEARCH TO THE EFFICIENT USE OF WATER IN AGRICULTURE,
Volcani Inst. of Agriculture Research, Bet-Dagan (Israel). Div. of Irrigation.
For primary bibliographic entry see Field 03F.
W69-05650

THE UDA WALAWE RESERVOIR PROJECT,
Department of Irrigation, Colombo (Ceylon). Div. of Planning, Research and Designs.
H. de S. Manamperi.
For 8 Volume Proceedings, see Vol 2, No 9, Field 06B and W69-03305. Int Conf on Water for Peace, Wash, D C, Vol 8, pp 182-198, 1968. 16 p, 6 fig, 1 tab.

Descriptors: *Water resources development, *Multiple-purpose projects, *Reservoirs, Hydroelectric power, Powerplants, Irrigation, River basin development, Social aspects, Economics, Canals, Dams, Human population, Migration, Water users.
Identifiers: *Ceylon, Uda Walawe Reservoir.

The Uda Walawe Reservoir is located on the Walawe Ganga (river), one of the large perennial rivers that drain the Island of Ceylon. The Walawe Ganga basin covers an area of 965 sq mi or approximately 4% of the total land area of the island. The dam consists of 2 earthen flank embankments, connecting to a concrete section across the river, a powerplant, irrigation outlets, one on each bank of the river. Increasing the reservoir by 23,000 acre-ft, together with the adoption of a new cropping pattern which included sugar, citrus and cotton in addition to rice, made it possible to increase the irrigable command of the reservoir to 60,000 acres. The cropping pattern took into account soil factors, rainfall, and the social and economic conditions in the project region, a very sparsely populated area. It was therefore necessary to plan for the settlement of people from other areas of the island on the lands to be developed under Uda Walawe. The transference of population into undeveloped jungle areas with a dry climate necessitates planning for access, water supply, housing, electric power, food, hospitals, schools, and markets. The project area was made accessible by opening a road network of about 70 mi. Over 3,000 families have already been settled on the project lands. (Knapp-USGS)
W69-05653

PHYSICO-TECHNICAL PROBLEMS IN MANAGING WATER RESOURCES (RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
For primary bibliographic entry see Field 02A.
W69-05660

LIST OF REFERENCES ON CONTROL OF AQUATIC PLANTS, INCLUDING ALGAE,
Chipman Chemical Co., Inc., Bound Brook, N. J. Research Div.
For primary bibliographic entry see Field 05G.
W69-05705

SUPPLEMENT TO THE LIST OF REFERENCES ON CONTROL OF AQUATIC PLANTS, INCLUDING ALGAE,
Chipman Chemical Co., Inc., Bound Brook, N. J. Research Div.
For primary bibliographic entry see Field 05G.
W69-05706

OPTIMAL OPERATING RULES FOR MULTI-RESERVOIR SYSTEMS,
Massachusetts Inst. of Tech., Cambridge.
Richard Michael Males.
Ph D Thesis, Mass Inst Technol, Cambridge, Mass, Aug 1968. 184 p, 20 fig, 14 tab, 22 ref, 3 append.

Descriptors: *Linear programming, *Simulation analysis, *Reservoir operation, Marginal benefits, Optimization, Comparative benefits, Analytical techniques, Digital computers, Computer models water policy, Water management (Applied).
Identifiers: *Multi-reservoir system, Sensitivity analysis, *Operating rules.

A technique called Linear Programming-Simulation-Search (LPSS) was investigated to analyze the problem of determining optimal operating rules for multiple reservoir systems. A linear programming model was used to obtain initial values for operating parameters. Starting with those values, simple search techniques of sensitivity, single-factor, and marginal analysis were used to determine near-optimal values of the parameters by searching the benefit response surface. The benefit response surface was defined through the use of a simulation model of the basin, which yielded values as a function of the various operating parameters. Three different computer simulation models were tested and their results indicated the feasibility of LPSS. It was concluded that steady-state linear programming models consistently gave lower release values than LPSS. (Gysi-Cornell)
W69-05723

MATHEMATICAL PROGRAMMING MODELS APPLIED TO A WATER RESOURCE SYSTEM,
Massachusetts Inst. of Tech., Cambridge.
Juan Antonio Poblete Reichhard.
M S Thesis, Mass Inst Tech, Dep Econ, Dep Civil Eng, Jan 1969. 325 p, 25 fig, 3 map, 110 tab, 57 ref, 7 append.

Descriptors: *Linear programming, *Mathematical models, *Water resources, *River systems, Multiple-purpose projects, Reservoir operation, River basin development, Simulation analysis.
Identifiers: Maule River Chile, Mixed integer linear programming.

Different mathematical programming model, set up for preliminary study of a multiunit, multipurpose river basin system on the Maule River in Chile, were analyzed. Three different steady-state, in-year storage linear programming (LP) models were developed, using increasing numbers of time periods in each. Two over-year steady state LP models were introduced. Finally a mixed integer LP model of the system. The advantages and drawbacks of each approach were discussed and compared. A discussion of the usefulness of the results, in relation to a simulation model of the system, was presented. (Gysi-Cornell)
W69-05725

DESIGN OF WATER-RESOURCE SYSTEMS,
Harvard Univ., Cambridge.
Arthur Maass, Maynard M. Hufschmidt, Robert Dorfman, Harold A. Thomas, Jr., and Stephen A. Marglin.
Cambridge, Harvard Univ. Press, 1962. 620 p, 98 fig, 93 tab.

Descriptors: *Water resources, *Systems analysis, *Mathematical models, *Economics, *River basins, Analytical techniques, Linear programming, Simulation analysis, Synthetic hydrology, Design, Decision making, Planning.

The results of a large-scale research program devoted to the methodology of planning or designing complex, multiunit, multipurpose water-resource systems were reported. A detailed presentation of methods and techniques for translating design criteria in designs of river-basin systems by means of combined economic and engineering analysis was given. The new methods of river-system design were compared with methods now in use. The two principal new techniques examined were the simulation of river-basin systems on digital computers and the construction of mathematical models that produce optimal decisions. (Gysi-Cornell)
W69-05729

MATHEMATICAL MODELS: A STOCHASTIC SEQUENTIAL APPROACH,
Harvard Univ., Cambridge, Mass.
Harold A. Thomas, Jr., and Peter Watermeyer.
Design of Water-Resource Systems, by Maass et al, Chap 14, pp 540-561, Harvard Univ Press, 1962. 22 p, 6 fig, 7 tab, 8 ref.

Descriptors: *Linear porgramming, *Stochastic processes, *Reservoir operation, Probability, Decision making, Queuing theory, Mathematical models, Optimization, Reservoir design, Reservoir storage.
Identifiers: Operating policies, Target outputs.

A stochastic linear programming model, used to determine optimal operating policies for given target outputs and reservoir size, and optimal policies and targets for given reservoir size was presented. The probability distribution of inflows for particular yearly design periods were assumed known and independent (no serial correlation). The objective was to maximize net benefits (a function of target level and short run loss or surplus drafts) subject to probability and continuity constraints. The model was designed for a single multi-purpose reservoir, with the benefits assumed additive. The solution, shown graphically, indicated the optimal draft in

any period for any level of available supply (inflow plus storage). The consistency of the linear programming solution was checked using a queuing theory model. (Gysi-Cornell)
W69-05730

OPTIMUM MANAGEMENT OF A COMBINED PUMPED HYDRO AND IRRIGATION STORAGE FACILITY,
Stanford Research Inst., Menlo Park, Calif.
William G. Keckler.
Pap, Stanford Res Inst, Mar 1966. 28 p, 8 fig, 2 ref.

Descriptors: *Dynamic programming, *Pumped storage, Pumping plants, *Irrigation, Reservoir operation, *Hydroelectric plants, Electric power rates, Optimization, *Water management (Applied), Water allocation (Policy), Water demand, Reservoir design, Planning, Design.

A forward dynamic programming model was structured to determine the optimum management policy for a combined pumped hydro and irrigation storage facility. The state variables were the upper and lower reservoir storages (quantized and normalized to six discrete values). The control variables were the rates of pumping between river and lower reservoir, and pumping-or-generating between the lower and upper reservoirs. Time increments of one hour were used for a study period of one day. Different values for electrical energy were charged at different hours of the day. The method of solution was described. The computer program was shown in a flow diagram. The results from a hypothetical problem were graphed and discussed. The advantages and limitations of the method for larger problems and longer time periods were outlined. (Gysi-Cornell)
W69-05734

CHICAGOLAND DEEP TUNNEL SYSTEM FOR POLLUTION AND FLOOD CONTROL: FIRST CONSTRUCTION ZONE, DEFINITE PROJECT REPORT.
Harza Engineering Co., Chicago, Ill.; and Bauer Engineering, Inc., Chicago, Ill.
For primary bibliographic entry see Field 05G.
W69-05743

ALLEN V STATE (FLOOD DAMAGE DUE TO CONSTRUCTION OF DIKE).
For primary bibliographic entry see Field 06E.
W69-05798

DIVERSION WORKS FOR CONSTRUCTION,
U S Army Corps of Engineers, Vicksburg, Miss.
James P. Stafford.
Pap, Amer Soc Civ Eng Nat Meet Water Resour Eng, New Orleans, La, Feb 1969. 61 p, 8 plate, 5 tab, 7 ref.

Descriptors: Construction, *Earth dams, Flood control, Safety, Floods, *Gravity dams, *Concrete dams, Mississippi, Arkansas, Geology, Climatic data, Multiple-purpose reservoirs, Runoff, Storage capacity, Streamflow, Atmospheric precipitation, River regulation, *Diversion works, Diversion tunnels, Hydrology, *Diversion, *Diversion structures.
Identifiers: *Streamflow regulation, Corps of Engineers, Grenada Dam (Miss), Narrows Dam (Ark), Blakely Mountain Dam (Ark), DeGray Dam (Ark).

Four projects constructed by the Vicksburg District, Army Corps of Engineers, on tributaries of the Yazoo River, Miss, and the Ouachita River, Ark, were selected as examples of diversion techniques for flood control dams. Climate, temperature conditions, precipitation, runoff, geology, diversion plans, and implementation for each of these projects are discussed. Reservoir data are tabulated for each project. Grenada Reservoir illustrates simpler techniques available in a wide river plain permitting alternate channel diversion with normal flow through a river gap with cofferdams protecting first stage embankments. Second stage diversion is through the flood control structure and conduit with cofferdams protecting second stage construction. Narrows Reservoir illustrates an alternate diversion over low monoliths of a concrete gravity dam in a narrow river valley. Blakely Mountain Reservoir is an example of diversion in a narrow river valley through flood control and power tunnels during the dry season. First season flood flows pass over first stage embankments with second stage embankments providing storage capacity to permit full diversion through tunnels. DeGray Reservoir illustrates dry season diversion through a joint flood control-power tunnel, the diameter determined by diversion requirements. (USBR)
W69-05816

FLOOD PROOFING IN A FLOOD PLAIN: A STOCHASTIC MODEL,
Engineering Construction Corp., Ltd, Bombay (India); and Carnegie Inst. of Tech., Pittsburgh, Pa.
Viraf S. Bhavnagri, and George Bugliarello.
Proc, Amer Soc Civil Eng, Vol 92, No HY4, pp 63-76, July 1966. 14 p, 2 fig, 2 tab, 40 ref, 1 append.

Descriptors: *Floodproofing, *Flood plains, *Mathematical models, *Stochastic processes, Statistical methods, Probability, Flood damage.
Identifiers: Expected values.

A mathematical model of an urban flood plain was presented which incorporated a statistical description of flood proofing measures. Measures that were contingent and dependent on the flood warning time were considered. Dynamic flood proofing was treated by a probabilistic approach which accounted for the uncertainty of flood warnings. The expected value and standard deviation of damage to the entire flood plain were expressed in terms of the 'flood proofing index,' which indicated the extent of dynamic flood proofing in the flood plain. The influence of the flood proofing index on the flood damage statistics was studied by means of a hypothetical example. (Gysi-Cornell)
W69-05851

MATHEMATICAL REPRESENTATION OF AN URBAN FLOOD PLAIN,
Carnegie Inst. of Technology, Pittsburgh, Pa.
Viraf S. Bhavnagri, and George Bugliarello.
Proc, Amer Soc Civil Eng, Vol 91, No HY2, pp 149-173, Mar 1965. 25 p, 9 fig, 3 tab, 12 ref, 3 append.

Descriptors: *Flood plains, *Mathematical models, *Flood damage, Statistical methods, Contours, Depth, Time series analysis, Economics, Reservoir design, Optimization.
Identifiers: Expected values.

A mathematical model was presented which formalized the computations of flood damages to an urban area. The flood depth-damage relationship of a structure was written as the product of a unit damage function and an individual characteristic damage coefficient. The sum of such coefficients for all establishments within a small contour interval of the flood plain denoted the damage susceptibility of that contour interval. The expected value and standard deviation of the present worth of a time series of damages was expressed in terms of the current contour characteristic damages and a growth-discount factor that accounted for changes in level of economic activity with time. A hypothetical example illustrated the application of the model for determining the optimal size of an upstream single-purpose flood control reservoir. (Gysi-Cornell)
W69-05852

ANALOG MODELS FOR FLOOD CONTROL SYSTEMS,
California Univ., Berkeley.
J. A. Harder.
Proc, Amer Soc Civil Eng, Vol 88, No HY2, pp 63-74, Mar 1962. 12 p, 3 fig, 4 ref, 2 append.

Descriptors: *Analog computers, *Rainfall-runoff relationships, *Flood control, Reservoir design, Reservoir operation, Project planning, Flood forecasting, Rainfall simulators, Time of concentration, State-discharge relationship.

Methods for the simulation of flood control channels were described, with particular attention paid to the non-linear properties of the stage-discharge and stage-storage relation. The introduction of boundary conditions in the form of streamflows and rainfall excesses was programmed for each six hours of the prototype, for a total period of ten days. Each simulated flood required five milliseconds, after which initial conditions of flow were reestablished in preparation for the next flood period. The time history of stage or discharge at any two of fifty stations could be displayed simultaneously on an oscilloscope screen. Provision was made for the insertion of up to six reservoirs into the analog, each of which was provided with a programmable output simulating the action of reservoir release gates. It was concluded that the analog would be useful in project planning and during flood emergencies. (Gysi-Cornell)
W69-05856

MATHEMATICAL MODEL FOR FLOOD RISK EVALUATION,
Cornell Univ., Ithaca, N. Y.
Richard M. Shane, and Walter R. Lynn.
Proc, Amer Soc Civil Eng, Vol 90, No HY6, pp 1-20, Nov 1964. 20 p, 8 fig, 3 tab, 5 ref, 2 append.

Descriptors: *Probability, *Mathematical models, *Risks, *Floods, *Duration curves, Statistical methods, Design flood, Data processing, Evaluation, Estimating equations.
Identifiers: Graphical methods, Poisson probability law.

A mathematical model was developed for use with partial-duration data that related design flow to several different measures of risk. The analysis was based on the Poisson probability law and the probability theory of sums of a random number of random variables. Design equations that related three measures of risk (recurrence interval distribution, encounter probability, and expected recurrence interval) to design discharge were derived. A statistical procedure was presented for estimating design equation parameters from a partial-duration series of data. A graphical procedure for solving the equations was also presented. (Gysi-Cornell)
W69-05860

EFFECTS OF SEEDING AND GRAZING ON INFILTRATION CAPACITY AND SOIL STABILITY OF A SUBALPINE RANGE IN CENTRAL UTAH,
Forest Service (USDA), Logan, Utah. Intermountain Forest and Range Experiment Station.
For primary bibliographic entry see Field 04D.
W69-05889

FLOOD PLAIN INFORMATION, CONLEY CREEK-SOUTH RIVER, METROPOLITAN ATLANTA, GEORGIA.
Corps of Engineers, Savannah, Ga.

Corps Eng Flood Plain Rep, July 1968. 53 p, 23 fig, 36 plate, 18 tab.

Descriptors: *Floods, *Flood damage, *Georgia, Flood plains, Flood control, Non-structural alternatives, Maximum probable flood, Historic flood.
Identifiers: Atlanta (Ga), Conley Creek, South River, Standard project flood, Intermediate regional flood.

Flooding of Conley Creek and South River, Atlanta, Georgia is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information

is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W69-05913

FLOOD PLAIN INFORMATION, CASEY CANAL SOUTH, SAVANNAH AND CHATHAM COUNTY, GEORGIA.
Corps of Engineers, Savannah, Ga.

Corps Eng Flood Plain Rep, June 1968. 35 p, 21 fig, 22 plate, 6 tab.

Descriptors: *Floods, *Flood damage, *Georgia, Flood plains, Flood control, Non-structural alternatives, Maximum probable flood.
Identifiers: Savannah (Ga), Chatham County, Casey Canal, Standard project flood, Intermediate regional flood.

Flooding of Casey Canal, Savannah and Chatham County, Georgia is described in a report of flood plain problems based on records of rainfall, runoff, and historical and present flood heights. Maps, photographs, profiles, and cross sections indicate the extent of flooding that has occurred and which may be expected to occur in the future. The information is for use in study and planning ways to minimize vulnerability to flood damages by control of flood plain use by zoning and subdivision regulations, the construction of flood protection works, or by combinations of these approaches. (Knapp-USGS)
W69-05914

METHODS FOR WORKING OUT A NATIONAL WATER BALANCE (RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
V. T. Turchinovich.
In 'Invest of Surface and Underground Runoff', (Issledovaniye Poverkhnostnogo i Podzemnogo Stoka), Moscow, 'Nauka', pp 26-81, 1967. 56 p, 1 tab, 17 ref.

Descriptors: *Water resources, *Water balance, *Economic prediction, *Water supply, Water pollution, Groundwater, Runoff, Water users, Water forecasting, Water-resources development, Planning, River basin development, River basins, River flow, Fish harvest, Reservoirs.
Identifiers: *USSR, Water planning, Water economy.

The purpose of this investigation was the analysis of the redistribution of water resources in the USSR for long-term planning of the development of national economy. However this goal is intimately connected with the practical problems of variable water use and conservation of water reservoirs and aquifers. It is also assumed that the analysis of national water balances and the best methods suitable for such redistribution should lead to more efficient water economy. The article contains the following chapters: (1) the purpose of water-economy balances; (2) the basic postulates of a method for working out national water balances; (3) preliminary water balance for a river basin or an industrial region; (4) examples of preliminary national water balances; and (5) a method of working out a precise national water balance. The article contains 17 references and 2-page supplement containing some regulations for protection of surface waters from waste waters confirmed by the Ministry of Health Protection, USSR, 15 July 1961. (Gabriel-USGS)
W69-05936

A MEANING OF NATIONAL WATER BALANCE IN RATIONAL USE OF WATER RESOURCES (RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
I. A. Kuznetsov.
In 'Invest of Surface and Underground Runoff', (Issledovaniye Poverkhnostnogo i Podzemnogo Stoka), Moscow, 'Nauka', pp 82-87, 1967. 6 p, 1 fig.

Descriptors: *Water resources, *Water supply, *Water distribution (Applied), *Water works, Runoff, Economics, Forecasting, Planning, Surface waters, Groundwater, Glaciers, Saline water, Water balance, Water basins, Water transfer.
Identifiers: *USSR, *National water balance, Water transfer, Caspian basin, Lake Ladoga.

The author briefly discusses the unequal distribution of runoff in the USSR and the need for water transfer from water-rich regions to dry ones. The existence of several canals, such as Moscow-Volga, Irtysh-Karaganda, and several hydroelectric stations are described and recommendations are made for the transfer of water from Lake Ladoga to the Volga-Caspian basin. Lake Ladoga has a drainage area of 276,000 sq km and the water volume of the lake is about 911 cu km; water transfer would not necessitate the flooding of adjacent areas. It was estimated that the transfer of 20 cu km of water into the central and southern areas can be accomplished by a canal 320 km in length and of 625 cu m/sec capacity. A schematic map of water transfer from Lake Ladoga to the Caspian Sea basin is attached. (Gabriel-USGS)
W69-05937

THE STABILITY OF NORMAL ANNUAL RUNOFF AND SEASONAL RIVER DISCHARGES UNDER CONDITIONS OF DEVELOPMENT OF AGROTECHNICAL ENTERPRISES IN THEIR DRAINAGE AREAS (RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
G. R. Yunusov.
In 'Invest of Surface and Underground Runoff', (Issledovaniye Poverkhnostnogo i Podzemnogo Stoka), Moscow, 'Nauka', pp 88-100, 1967. 13 p, 6 fig, 6 tab, 16 ref.

Descriptors: *Water resources, *Agronomic crops, *Runoff, *Water distribution, Economics, Surface water, Subsurface flow, Water balance, Groundwater, River flow, Water control, Water harvesting, Water users.
Identifiers: *USSR, Stability of runoff, Don River, Dnieper River.

Annual runoffs and seasonal discharges of the Don and Dnieper Rivers were investigated at various points beginning with observations in 1877 and 1881 for the respective rivers. The study shows that relatively no substantial decrease has occurred in the annual runoffs of these rivers and no change has been identified in the amount of evaporation due to the agricultural activities in the basins. In general the stability of annual runoffs of the Don and Dnieper Rivers indicates the stability of runoffs in all their seasonal formation stages. Although the Don River shows some decrease (down 3%) in the spring runoffs and some increase (up to 5%) in the base flow periods, nevertheless the effect of agricultural activities on the values of river runoff may be considered of importance only in the areas characterized by extensive agricultural development. (Gabriel-USGS)
W69-05938

MUD FLOWS IN THE TRANSILIAN ALA-TAU AND THE MUD FLOW CATASTROPHE OF 7 JULY, 1963 IN THE ISSYK RIVER BASIN (IN RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
For primary bibliographic entry see Field 02E.
W69-05944

METHODS OF PREVENTING MUDFLOWS (IN RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
I. I. Mechitov.
In 'Invest of Surface and Underground Runoff', (Issledovaniye Poverkhnostnogo i Podzemnogo Stoka), Moscow, 'Nauka', pp 169-174, 1967. 6 p, 55 ref.

Descriptors: *Mudflows, *Runoff, *Water control, Drainage system, Flood damage, Flood forecasting, Economic justification, Hydrologic properties, Technical feasibility, Economy, Forest management, Barriers, Basins, Structures.
Identifiers: *USSR, *Mudflow control, Ukraine, Central Asia, Caucasus, Armenia.

Methods of preventing mudflows are discussed on the basis of several earlier publications by USSR investigators. The author concludes that effective mudflow control may be achieved only by reliable flood forecasting and by detailed studies of the hydrologic, technical, economic, and other conditions present in the mudflow areas. Choice of a control method cannot be made in a general form because each mudflow basin demands its own specific solution. Studies by Lakhtionov (1962) and Ibad-Zade (1962), describe mudflow prevention in the Alma-Atu area and indicate the effectiveness of using several prevention methods simultaneously. (Gabriel-USGS)
W69-05945

IMMENSE LANDSLIDE OBSTRUCTION OF ZERAVSHAN RIVER, APRIL 24, 1964 (IN RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
For primary bibliographic entry see Field 02E.
W69-05946

ALLEY V FICKEL (DIVERSION OF WATER BY LEVEE).

49 NW 2d 544-547 (Iowa 1951).

Descriptors: *Iowa, *Levees, *Floodwater, *Streams, Diversion, Diversion structures, Legal aspects, Judicial decisions, Riparian land, Natural flow, Conservation, Remedies, Damages, Alteration of flow, Embankments.
Identifiers: Injunctions (Mandatory).

Defendant, owner of property adjacent to plaintiff's property, constructed a levee on a stream that flowed through his property. The levee was built in compliance with good conservation practice. During a flood plaintiff's property was damaged by water flowage claimed to have been diverted by the defendant's levee. Plaintiff sought to enjoin defendant from further use of the levee. The trial court held for plaintiff and ordered defendant to remove a portion of the levee. In affirming the trial court, the appellate court stated that a riparian proprietor may not embank against the natural overflow when the effect may be to cast an increased volume of water to the detriment of other proprietors. A lower proprietor is not required to receive the drainage diverted in his direction by artificial means. The court felt that since a part of the levee was actually washed away during the flood, the levee was the direct cause of the excess water. (Holt-Fla)
W69-05957

KAY-NOOJIN DEV CO V KINZER (SURFACE WATERS AND THE NATURAL FLOW DOCTRINE).

65 So 2d 510-516 (Ala 1953).

Descriptors: *Diffused surface water, *Natural flow doctrine, *Surface runoff, *Alabama, Surface waters, Drainage systems, Flooding, Surface drainage, Channels, Pipes, Drains, Ditches, Surface-groundwater relationships, Culverts, Drainage water, Slopes, Streamflow, Alteration of flow, Judicial decisions, Legal aspects.
Identifiers: *Nuisance, *Upper landowners, *Lower landowners.

Plaintiff brought this suit to recover for damages caused by the casting of surface water upon his land after it was diverted from its natural course. The defendant, a housing developer, made himself the highland proprietor by building up the land. The defendant was not shown to be negligent in the construction of his sewer and drainage systems. Nevertheless, the drainage system caused unusually large quantities of surface water to be cast upon plaintiff's low land property. The court held that the defendant, upper proprietor, was liable for the damage caused by the diversion of surface water from its natural course. (Stewart-Fla)
W69-05958

PANAMA CITY V YORK (SURFACE WATERS AND THEIR NATURAL FLOW).

26 So 2d 184-186 (Fla 1946).

Descriptors: *Florida, *Natural flow, *Diversion, *Surface runoff, Judicial decisions, Streamflow, Obstruction to flow, Diversion structures, Drainage systems, Surface waters, Controlled drainage, Ditches, Cities, Streamflow, Alteration of flow, Legal aspects.
Identifiers: *Lowland proprietors.

Plaintiff brought suit against defendant municipality for damages resulting from the diversion of water from its natural flow onto the property of the plaintiff. In holding for the plaintiff, the court ruled that no person has the right to gather surface waters that would naturally flow in one direction and divert them from their natural course onto the lands of a lowland owner and to his detriment. (Stewart-Fla)
W69-05959

ADAMS V LAWLER (SURFACE WATERS AND THE NATURAL FLOW DOCTRINE).

4 Chester County Reports 89-95 (CP Pa 1948).

Descriptors: *Pennsylvania, *Embankment, *Natural flow doctrine, *Surface runoff, Obstruction to flow, Drainage systems, Flooding, Surface drainage, Rainfall-runoff relationships, Streamflow, Drainage water, Slopes, Judicial decisions, Surface waters, Legal aspects.
Identifiers: *Lowland proprietors, *Upper landowners.

Plaintiffs brought this suit to restrain the defendants from interfering with the natural flow of surface water from the plaintiffs' land. Defendants were lowland proprietors and water draining from the plaintiffs' land followed a natural course across their own land. Defendants constructed an embankment which impeded the natural flow of the water. The result was serious flooding and backing up of the water onto the plaintiffs' land. The court granted plaintiffs' request for an injunction, finding that the defendants had obstructed the natural flow of surface waters from the plaintiffs' property. This caused damage to the land and interfered with plaintiffs' use and enjoyment of it. (Stewart-Fla)
W69-05960

NEWTON COCA COLA BOTTLING CO V MURPHREY (DIVERSION OF SURFACE WATERS).

55 So 2d 485-489 (Miss 1951).

Descriptors: *Mississippi, *Artificial watercourses, *Surface runoff, *Diversion, Surface waters, Drainage systems, Judicial decisions, Ditches, Surface drainage, Natural flow doctrine, Drainage water, Surface drainage, Channels, Diffused surface water, Slopes, Storm runoff, Legal aspects, Alteration of flow.

Plaintiff brought suit to recover for damages caused by the wrongful diversion of surface waters from defendant's land onto that of the plaintiff. The court found that the defendant caused the surface water to become concentrated in an artificial manner and then discharged upon the land of the plaintiff in a more concentrated flow than would have naturally occurred. The recognized rule is that a landowner cannot collect surface water into an artificial channel and precipitate it in greatly increased quantities upon his neighbor's property causing substantial damage. Judgment for the plaintiff was affirmed. (Stewart-Fla)
W69-05961

YONADI V HOMESTEAD COUNTRY HOMES (SURFACE WATERS AND THE NATURAL FLOW DOCTRINE).
35 N J Super 514, 114 A 2d 564-569 (App Div 1955).

Descriptors: *New Jersey, *Surface drainage, *Surface runoff, *Natural flow, Surface waters, Channels, Culverts, Runoff, Drainage water, Time of concentration, Surface-groundwater relationships, Drainage systems, Groundwater movement, Flow measurement, Drains, Ditches, Judicial decisions, Alteration of flow, Flow augmentation, Legal aspects.
Identifiers: *Upper landowners, *Lower landowners.

Plaintiffs filed suit to recover damages for the casting of casual surface waters onto their land. Defendants, upper landowners, erected houses on their land and constructed drains to remove surface water. The principal question is whether defendants are to be charged with liability for a resultant increase in the flow of surface water which runs onto the plaintiffs' land. The trial court found for plaintiffs. The superior court, reversing, held that the casting of surface waters in increased quantities through artificial means onto the land of another, without more, is not unlawful. The general rule is that neither the diversion nor the altered transmission of surface water gives rise to actionable injury. The water diverted by the defendant continued to flow into the locality where it would naturally have flowed. The burden of the increased quantities is put on the lowland proprietor. The increased quantity and force was a necessary incident of the legitimate beneficial user, and any injury arising therefrom was not actionable. (Stewart-Fla)
W69-05962

MISKOTTEN V DRENTEN (ARTIFICIAL DRAINAGE OF SURFACE WATERS).

318 Mich 538, 29 NW 2d 91-94 (1947).

Descriptors: *Michigan, *Surface runoff, *Artificial watercourses, *Drainage systems, Embankment, Surface waters, Ditches, Floods, Storm runoff, Surface drainage, Rainfall-runoff, Diffused surface waters, Precipitation excess, Property boundaries, Drains, Flow augmentation, Legal aspects, Judicial decisions.

Plaintiffs brought action to enjoin defendants from constructing an embankment near the drainage ditch which served as the boundary line between their respective properties. The problem arose when the neighboring river flooded the lands of both parties after a heavy rainfall. The plaintiffs dug drainage ditches perpendicular to the ditch that served as the property line. Defendant sought to build an embankment to keep the water coming from the plaintiff's land from flowing onto his land. The court ruled for the defendant, holding that the right to drain surface water cannot be exercised by concentrating or releasing it upon adjacent property by means of an artificial ditch, in greater quantities or forces than would otherwise be natural. The plaintiff had no right to collect water in ditches and dump it upon the lands of an adjoining owner. (Stewart-Fla)
W69-05963

UPPER GREENWOOD LAKE PROPERTY OWNERS ASS'N V GROZING (CONTROLLED USE OF LAKE WATERS).
6 N J Super 538, 69 A 2d 896-899 (1949).

Descriptors: *New Jersey, *Ownership of beds, *Lakes, *Relative rights, Judicial decisions, Legal aspects, Lake beds, Fishing, Boating, Bodies of water, Recreation, Water utilization, Water users, Land development, Land use, Lake soils, Lake shores, Obstruction to flow.
Identifiers: Injunctions (Prohibitory), Covenant running with land.

A developer created a group of lakefront lots by damming a brook. Deeds from this developer granted fishing rights in the lake and subjected such rights to the privilege of adjoining owners to use the lake for like purposes. Property owners in the development formed plaintiff corporation to operate the lake for the benefit of the owners. The developer conveyed land to the plaintiff, which conveyance included 90 per cent of land beneath the lake. This deed contained covenants affecting lake use, which were common to all deeds of development owners. Several owners began renting boats for public fishing. Plaintiff sued in equity, praying that defendants be enjoined from renting boats for public fishing on the lake. Injunctive relief was granted against all but the one defendant to whom prior permission to rent boats had been given. The court ruled that the privilege to fish was a right appurtenant to and running with the land. Such right could not be transferred to others, even temporarily, without transferring the land itself. Plaintiff was held to have the right to control lake use, subject only to rights of adjoining owners. (Wheeler-Fla)
W69-05966

VINSON V TURNER (INJUNCTION AGAINST CONCENTRATION OF SURFACE WATER RIDDANCE).

40 So 2d 863-866 (Ala 1949).

Descriptors: *Alabama, *Riddance (Legal aspects), *Relative rights, *Surface runoff, Drainage effects, Overflow, Ditches, Natural flow, Natural flow doctrine, Damages, Running waters, Surface waters, Channels, Water spreading, Discharge (Water), Flow augmentation, Channel flow, Overlying proprietor, Water law, Legal aspects.
Identifiers: Injunctions (Mandatory).

Petitioners owned farm lands adjacent to and lower than respondent's land. Roadside ditches discharged surface waters into a ditch running across respondent's land to petitioners' land. The county once cleaned out this ditch across respondent's land, but it later became filled. In order to protect his well from water spreading and to cultivate more land, respondent did not reopen the old ditch but created a separate drainway which emptied waters upon complaints' land at a different location. Petitioners, alleging damages from the concentrated flow, sought a mandatory injunction forcing respondent to reopen the old ditch. The trial court found for respondent. The appellate court affirmed, following Alabama's modified civil law rule concerning surface water riddance. The rule provides that an upper landowner may rid his land of surface waters as he sees fit, provided such riddance does not cause detriment to the lower estate. Under exceptional circumstances, the upper owner is permitted to prudently exercise the right to concentrate water which previously flowed by divers channels over a wider area and to discharge such waters on the lower estate. The jury found that this right existed in the circumstances of this case. (Wheeler-Fla)
W69-05967

ATCHISON T AND S F RY V TAYLOR (FLOOD DAMAGE DUE TO RAILWAY EMBANKMENT).

87 F Supp 313-318 (ED Mo 1949).

Descriptors: *Missouri, *Railroads, *Legislation, *Embankments, Legal aspects, Judicial decisions, Ditches, Overflow, Flood damage, Drainage systems, Surface waters, Overlying proprietor, Surface runoff, Floodwater, Control structures, Flood protection, Flood control, Channels, Backwater, Water law, Relative rights, Riddance (Legal aspects), Repulsion (Legal aspects), Obstruction to flow.
Identifiers: Proximate cause.

To avoid a multiplicity of suits arising out of a flood, plaintiff railroad sought a declaratory judgment against defendant individuals and drainage districts. Defendants filed counterclaims for damages, alleging that the railroad embankment obstructed an overflow of waters by failure to provide adequate bridging of ditches, drains, and watercourses as required by state statute. Plaintiff contended that any damages were due to an act of God and not to any failure to observe statutory requirements. The court found for the plaintiff and denied the counterclaims, stating that the only issue was whether plaintiff complied with the statute. The court held that the statute did not require construction of openings in the embankment unless such opening would connect with a ditch, drain, or watercourse. Plaintiff's embankments fulfilled the statutory requirements. The court also stated that flood waters should be treated as surface waters, and that the effect of the statute was to modify the common-enemy rule with respect to railroad embankments. (Wheeler-Fla)
W69-05968

KECK V HAFLEY (DIVERSION OF STREAM FLOW).

237 SW 2d 527-530 (Ky 1951).

Descriptors: *Kentucky, *Eminent domain, *Diversion, *Natural flow, State governments, Damages, Remedies, Streams, Channel flow, Stream flow, Floods, Condemnation, Obstruction to flow, Judicial decisions, Legal aspects.
Identifiers: Inverse condemnation.

Plaintiff brought suit alleging that state officials, in the construction of a highway next to his land, had changed the channel of a creek. This diversion of the natural flow resulted in the inundation of his land and crops. The lower court held for the plaintiff, and the state appealed. Although reversing on other grounds, the court held that changing a creek channel and diverting the natural flow of a stream so as to cause inundation of land is a taking of property. The court stated that a suit for damages by the owner was in effect a reverse condemnation. (Gabrielson-Fla)
W69-05969

COMMONWEALTH V KELLEY (NEGLIGENT OBSTRUCTION TO FLOW).

236 SW 2d 695-698 (Ky 1951).

Descriptors: *Compensation, *Kentucky, *State governments, *Obstruction to flow, Overflow, Diversion, Eminent domain, Condemnation, Natural flow, Culverts, Ditches, Remedies, Judicial decisions, Flood damage, Relative rights, Discharge (Water), Operation and maintenance.

Plaintiff brought suit to recover for injury to his land which allegedly resulted from the negligent management and operation of an adjacent highway and culvert system. Evidence tended to show that after heavy rains the culverts overflowed, depositing mud on appellee's land and damaging the foundations of his house. From a judgment awarding $1,000 in damages, the state appealed. While reversing on other grounds, the court held that if culverts were allowed to overflow so as to discharge surface waters upon adjacent land, such discharge would constitute a trespass. Such a trespass amounts to nothing less than a taking of private property for public use and requires compensation. (Gabrielson-Fla)
W69-05970

FINDLEY LAKE PROPERTY OWNERS, INC V TOWN OF MINA (MAINTENANCE AND CONTROL OF WATER LEVEL OF LAKE).
154 NYS 2d 775-809 (SC 1956).

Descriptors: *New York, *Dams, *Prescriptive right, *Water levels, Judicial decisions, Flow, Lakes, Wells, Navigable waters, Easements, Water rights, Recreation.

Plaintiff, owners of the dam through which Findley Lake drained, had allowed the water level to lower in order to repair the dam and remove weeds threatening to ruin the lake. Defendant had taken over control of the dam to raise the water level, alleging imminent danger to life, health and property by reason of the exposed bed and existence of a prescriptive right and public interest in the minimum level of the lake. Plaintiff sought a judgment of eviction and injunction preventing trespass and control of the dam by defendant. The court held that plaintiff had acquired the right to flowage of the lake to the extent of its predecessor in title. The evidence was held insufficient to show a nuisance detrimental to life, health and property. The lowering of the water level was held to not deprive property owners on the lake of prescriptive right in the maintenance of a certain water level. Plaintiff's predecessors in title had never recognized any obligation to maintain a minimum level, and therefore the public had only a permissive right to use the waters at the level maintained. Thus the defendant's action constituted an unlawful taking of plaintiff's property. (Childs-Fla)
W69-05973

COATES V UNITED STATES (DIKES AS THE PROXIMATE CAUSE OF FLOODING).
110 F Supp 471-476 (Ct Cl 1953).

Descriptors: *Missouri, *Streams, *Navigable rivers, *Flooding, Floodwater, Farms, Flow rates, Natural flow, Missouri River, Running waters, Dikes, Riparian lands, Riparian rights, Banks, Judicial decisions, Legal aspects.
Identifiers: Proximate cause.

Plaintiffs brought action to recover just compensation for the taking of certain lands and crops by defendant. Plaintiffs contend that the acts of defendant: (1) increased the water surface elevation of a river, thereby increasing flood stages; (2) caused an increase in the velocity of the flood waters over plaintiffs' land; and (3) resulted in a taking of plaintiffs' property without due process of law. The defendant denied the acts attributed to him. Further, defendant contended that an increase in the velocity of the river as a result of the acts complained of effected only indirect and inconsequential damage. The court held that the plaintiffs had failed to prove that construction of the dikes by defendant had caused the flood damage suffered. (Katz-Fla)
W69-05978

BOROUGH OF AUSTIN V A AND P CORRUGATED BOX CORPORATION (FLOODING BELOW A DAM).

60 Pa D and C 166-194 (C P 1947).

Descriptors: *Pennsylvania, *Flooding, *Impounded waters, *Dams, Reservoirs, Streams, Overflow, Flood damage, Riparian rights, Riparian lands, Runoff, Storm runoff, Precipitation excess, Surges, Waves (Water), Judicial decisions, Legal aspects.
Identifiers: Proximate cause, Act of God.

Defendant's negligently maintained dam collapsed during a very heavy rainfall causing extensive damages to plaintiff town. The plaintiff obtained a $35,000 verdict below, and the defendant sought a judgment non obstante veredicto. The court held that the defendant was liable for the entire amount of damage caused by his negligence in concert with an act of God. The court denied the defendants contention that the extraordinary rainfall alone would have caused the flooding complained of by the plaintiff. The court found that the amount of damages awarded was incorrectly determined and ordered a remittitur in defendant's favor. (Katz-Fla)
W69-05979

UNITED STATES V 2973 ACRES OF LAND (CONDEMNATION OF FLOWAGE EASEMENTS).
For primary bibliographic entry see Field 06E.
W69-05984

MOLTION V STATE (FLOODING ABOVE A DAM).

84 NYS 2d 521-527 (Ct Cl 1948).

Descriptors: *New York, *New York State Barge Canal, *Dams, *Flood damage, Flooding, Lakes, Canals, Legal aspects, Judicial decisions, Flood control, Erosion, Flood gates, Dam construction, Dam failure, Water levels, Navigable waters, Rivers, Ice, Operation and maintenance.

Plaintiffs sued to recover for damage caused by the flooding of Lake Oneida. They alleged that lake level was raised due to the negligent operation of the state dam located on the lake. The state claimed the structures were erected to facilitate operation of the Barge Canal and not for flood control purposes. The court held that if the state operated the canal in such a way as to cause damage to plaintiffs' property, it is legally responsible for the injuries caused. The state had a duty to watch the water level more closely and to open the gates at the dam at an earlier date. The state, in changing the natural water level of the lake in order to enhance the navigability of the canal system, became liable for damages to property owners whose lands were flooded as a result of such action. (Shevin-Fla)
W69-05988

BLACK V STATE (FLOODING OF LAND BY THE STATE).
195 Misc 484, 90 N Y S 2d 766-769 (Ct Cl 1949).

Descriptors: *New York, *Flooding, *New York State Barge Canal, *Prescriptive rights, Lakes, Dams, Canals, Judicial decisions, Legal aspects, Flood control, Flood damage, Erosion, Floodgates, Dam construction, Dam failure, Water levels, Navigable waters.

Claimants sued the state for flood damages caused by the negligent construction and maintenance of a dam. The dam had inadequate flood control facilities. The state claimed it had used the lake regularly over the last 20 years in each navigation season. The state contended that it had thus acquired a prescriptive right to flood the lands in question. The court held that the evidence was insufficient to establish that the state had acquired this right with regard to claimants' properties. The awards were granted. (Shevin-Fla)
W69-05989

HANCOCK V STULL (OBSTRUCTION TO NATURAL FLOW OF SURFACE WATER).
110 A 2d 522-524 (Md Ct App 1955).

Descriptors: *Maryland, *Obstruction to flow, *Surface waters, *Artificial watercourses, Ditches, Natural flow, Reasonable use, Water law, Legal aspects, Judicial decision, Walls, Barriers, Stream improvement, Equitable apportionment, Repulsion (Legal aspects), Drains, Alteration of flow, Remedies.

Plaintiff owned property adjacent to and above defendant's property. The natural flow of surface water was from plaintiff's land onto defendant's land until defendant graded his land. After grading, defendant created an artificial ditch midway

through his property which collected surface water and passed it onto plaintiff's property. Defendant constructed a concrete wall to obstruct the artificial channel. Plaintiff brought this action to have defendant enjoined from obstructing the natural drainage of surface water. The court stated that generally upper landowners are entitled to have surface water flow naturally over lower land without the flow being obstructed. However, upper owners may not discharge water into an artificial channel that results in more than the natural flow. If such a flow is created, the lower owner may protect his property. As an equitable solution the court ordered that the wall be removed and that plaintiff construct a valley gutter along the common property line. The court said that when a strict application of the general rule results in hardship the 'reasonableness of use' rule should be applied. (Holt-Fla)
W69-05990

INDIAN GRAVE DRAINAGE DIST V CONDRON (SUIT TO ESTABLISH RIGHTS OF PERSON OUTSIDE DRAINAGE DISTRICT).
2 Ill 2d 183, 117 NE 2d 96-98 (1954).

Descriptors: *Illinois, *Drainage districts, *Remedies, *Settling basins, Judicial decisions, Watershed (Basins), Artificial watercourses, Silting, Downstream, Riparian rights, Streams, Levees, State governments, Diversion, Alteration of flow, Legislation, Damages, Relative rights.
Identifiers: Standing.

Landowners within a drainage district instigated a petition praying that the commissioners be ordered to abandon all holding basins within that district. The state's attorney filed a motion on behalf of individuals outside the drainage district to dismiss the petition. The main issue was whether the individuals outside the district fell under the statutory definition of 'interested persons' so as to have standing to contest the petition. The court ruled that drainage districts are creatures of the state and are set up for the exclusive benefit of the territory within the district. Therefore, only those within the district are 'interested persons' within the meaning of the clause confering standing to appear and resist an application for abandonment. Those injured property owners outside the district whose property rights are prejudiced by occurrences within the district may maintain an action for damages or seek some other appropriate remedy against the drainage district. (Logan-Fla)
W69-05993

GROBART V NORTH JERSEY DIST WATER SUPPLY COMMISSION (DIVERSION OF FLOW).

58 A 2d 796-799 (N J Ct Ch 1948).

Descriptors: *New Jersey, *Land tenure, *Obstruction to flow, *Alteration of flow, Diversion structures, Water distribution (Applied), Water districts, Reasonable use, Relative rights, Easements, Hydraulic structures, Water supply, Streams, Judicial decision, Legal aspects, Real property, Remedies, Potable water, Water users.

The plaintiff brought this action to have defendant water district enjoined from diverting waters from a tributary of the Passaic River. The plaintiff alleged that she was owner of certain lands downstream from the point of diversion and that she was entitled to full use and enjoyment of the waters flowing in the stream. The defendant asked plaintiff to prove her title. Plaintiff could only show a dower right in the property in question. The court held that the defendant's grantor by virtue of a deed from the state was entitled to make authorized diversions from the stream in question and that the defendant could exercise this right by substitution. The plaintiff contended that the defendant was diverting water from the stream in a different manner than its predecessor in title. The court, in refusing to issue an injunction, indicated that the method of diversion could be modified by a successor as long as the amount of water so diverted remains constant. (DKatz-Fla)
W69-05994

JENNINGS V LEAGUE OF CIVIC ORGANIZATIONS (BREACH OF CONTRACT TO PRODUCE WATER).
180 Pa Super 398, 119 A 2d 608-611 (Pa Super Ct 1956).

Descriptors: *Pennsylvania, *Water contracts, *Reservoir sites, *Water sources, Legal aspects judicial decision, Contracts, Benefits, Reservoir construction, Reservoir storage, Impounded waters, Testing, Shales, Excavation, Rock excavation, Water supply, Supply contracts, Water storage, Water table, Construction, Compensation, Construction costs.
Identifiers: Express warranties.

Defendant was in great need of water for use in certain picnic grounds. Plaintiff contractor offered to construct a reservoir upon defendant's property, and represented that he would guarantee to supply all the necessary water. He further represented that if he did not produce sufficient water he would forfeit all compensation. Defendant, having no knowledge of the proposed type of construction, relied on the plaintiff's representations and hired him to perform the work. Because the reservoir was built in shale rock, it would only hold water in wet seasons. It, therefore, proved inadequate for defendant's needs. Defendant refused to pay, and plaintiff sued for the contract price. In affirming the jury verdict for defendant, the appellate court held that plaintiff, by his breach of express warranty to produce water, forfeited the right to compensation even for expenses. The court noted that the reservoir, where it was built, was of no value to defendant. Plaintiff should have known this before beginning construction. (Wheeler-Fla)
W69-05995

GEORGIA POWER CO V DREESE (NEGLIGENT WATER DISCHARGE).

51 SE 2d 724-728 (Ga 1949).

Descriptors: *Drowning, *Discharge (Water), *Georgia, *Dams, Overflow, Electric powerplants, Fishing, Judicial decisions, Legal aspects, Water law, Boats, Rivers, Recreation, Hazards.
Identifiers: Licensee, Duty of care, Respondeat superior, Fact questions, Invitee.

Plaintiff claimed that defendant power company negligently caused the death of plaintiff's husband. While plaintiff and her husband were fishing in a boat below defendant's power dam, employees of the defendant opened the flood gates causing 2 to 3 foot waves in the river below. The waves capsized the boat, and plaintiff's husband drowned. Plaintiff alleged that the river below the dam was commonly fished by the public with defendant's knowledge, that deceased was an invitee, and that defendant had a duty to keep the premises in a safe condition. The court held that plaintiff's husband was a licensee since the privilege to fish in the river was for his sole benefit. The defendant had the duty to use ordinary care to avoid injuring a licensee when his presence was known or reasonably to be anticipated. Whether defendant's employees breached this duty of ordinary care and whether such action by the employees under the circumstances amounted to wilful and wanton conduct were proper questions for the jury. (Holt-Fla)
W69-05996

LEVIN V MYERS (DISCHARGE OF SURFACE WATERS).

211 Ga 474, 86 SE 2s 283-285 (1955).

Descriptors: *Georgia, *Surface waters, *Discharge, Natural flow, Drainage, Surface runoff, Overland flow, Reuplsion (Legal aspects), Riddance (Legal aspects), Drainage water, Judicial decisions, Legal aspects.
Identifiers: Injunctions (Mandatory), Injunctions (Prohibitory).

Plaintiff brought action to enjoin defendant from causing the discharge of surface water upon plaintiff's lands, and defendant filed a cross-petition seeking similar injunctive relief. Defendant was permanently enjoined, and the parties were allowed sixty days to effectuate the decree. Durin said period, defendant filled the gap in the coping on the top of her driveway and wall, but she also cut several new holes at various places along the coping. Plaintiff filed motion alleging that defendant had aggravated rather than remedied the nuisance and prayed for such further relief as would prevent defendant from discharging surface water upon his property. The trial court entered a permanent injunction, and defendant appealed. The court found that, under the pleadings and evidence, the decree permanently enjoining defendant from causing or permitting the discharge of any surface water upon the property of plaintiff was proper and the judgment was affirmed. (Reed-Fla)
W69-05997

LOCH SHELDRAKE ASSOCIATES, INC V EVANS (RESERVATION OF REASONABLE USE).

306 N Y 297, 118 NE 2d 444-451 (1954).

Descriptors: *New York, *Lakes, *Easements, *Impoundments, Mill dams, Pipes, Conveyance structures, Hydraulic structures, Artificial use, Riparian rights, Reasonable use, Overlying proprietor, Appropriation, Water rights, Judicial decisions, Legal aspects.
Identifiers: Easements appurtenant, Easements in gross, Licenses.

The plaintiff's predecessor in title received a deed from one Devine conveying to plaintiff the whole of the lake and shore in question but specifically reserving the right and privilege to dam the lake and to use the impounded waters up to the natural low water mark. The grantor also reserved the right to pipe such water to his downstream property, referred to as the 'mill lot.' The grantor later conveyed the mill lot and the reserved water rights to the defendant. The defendant operated a hotel business adjacent to the mill lot and commenced utilization of the water diverted to the mill for business purposes. Plaintiff brought action for a declaratory decree that the reservation of water rights by the common grantor created an easement appurtenant to the mill lot and for use of the mill only. The court held that the language of the reservation created an absolute privilege and right to use the water in whatever manner desired up to the low water mark and did not indicate an intent to create an easement. (Katz-Fla)
W69-05998

HALSRUD V BRODALE (PRIVATE DRAINAGE EASEMENT AGREEMENTS).

72 NW 2d 94-101 (Iowa 1955).

Descriptors: *Iowa, *Easements, *Drainage systems, *Tile drainage, Judicial decisions, Water law, Legal aspects, Drainage, Natural flow, Obstructions to flow, Relative rights, Alteration of flow.
Identifiers: Injunctions (Prohibitory).

Plaintiff sought to restrain defendant from obstructing a drain tile, and defendant counterclaimed for an injunction to restrain plaintiff from draining additional lands through the drain obstructed. In 1916, a private agreement for drainage was entered into by the grantors of the parties. The agreement provided for the drainage of section 35. Plaintiff purchased the dominant tenement, while defendant became owner of the servient estate.

Subsequently, plaintiff acquired land adjacent to his original tract. He constructed a drain tile on this adjacent land and connected it to the drainage system in section 35. The defendant then obstructed the drain tile, and this action was initiated. The court rejected plaintiff's claim and granted defendant's counterclaim for an injunction prohibiting plaintiff's draining section 2 through the existing easement. The court applied the rule that a drainage easement cannot be enlarged to accommodate property not within the original agreement without stipulation of the landowners. The connection of the two drainage systems constituted a violation of the implied terms of the easement for section 35. (Holt-Fla)
W69-05999

STATE V BROWNS, INC (OBSTRUCTION OF DRAINAGE EASEMENTS).

18 NJ Super 327, 87 A 2d 54-56 (1952).

Descriptors: *New Jersey, *Easements, *Drainage water, *Highways, Flood water, Judicial decisions, Legal aspects, Pipes, Watercourses (Legal), Surface waters, Channels, Water law, Obstruction to flow, State governemnts, Relative rights, Diversion losses.

Defendants acquired their property subject to prior easements in favor of the plaintiff. These easements gave plaintiff the right to drain excess surface water into a stream which flowed through defendants' property. Due to diversion of a substantial quantity of stream water, the natural channel flowing through defendants' property became dry. Subsequently, defendants filled in the natural channel and in so doing covered a state highway drain. This caused flooding of the highway and precipitated this action by the state to remove the obstruction. The court held that defendants would be required to provide adequate drainage for the surface water flowing from the highway. (Holt-Fla)
W69-06000

4B. Groundwater Management

RULES OF TRANSFER OF WATER MANAGEMENT EXPERIENCE, WITH SPECIAL REFERENCE TO THE ASSESSMENT OF DRAINAGE DESIGN CONSTANTS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 04A.
W69-05614

THE CONTRIBUTION OF RESEARCH TO THE EFFICIENT USE OF WATER IN AGRICULTURE,
Volcani Inst. of Agriculture Research, Bet-Dagan (Israel). Div. of Irrigation.
For primary bibliographic entry see Field 03F.
W69-05650

STEP-DRAWDOWN TEST NEEDS CRITICAL REVIEW,
Universal Oil Products, St. Paul, Minn.
Joe L. Mogg.
Ground Water, Vol 7, No 1, pp 28-34, Jan-Feb 1969. 7 p, 5 fig, 1 tab, 13 ref.

Descriptors: *Water wells, Water yield, *Specific capacity, *Drawdown, *Wells, Groundwater, Groundwater mining, *Aquifers, Discharge (Water), Efficiencies, Discharge coefficients.
Identifiers: *Step-drawdown tests, Groundwater hydrology, Well yield, Pumping tests.

Well testing by the step-drawdown procedure is reviewed; examples show that presently used analysis and interpretation can be misleading. The usefulness of step-drawdown tests is discussed for determining well efficiency, predicting drawdown, selecting pumping rates, and predicting specific capacity at various discharge rates. Certain step-drawdown tests show a large reduction in specific capacity not attributed to turbulent losses in the formation. Reduction of specific capacity may be caused by aquifer compaction because of reduction in aquifer pressure. The step-drawdown test can reasonably predict drawdown and specific capacity, but should not be used to determine efficiency of a water well. The step-drawdown test should not be used for wells in water table aquifers unless the reduction in saturated thickness is small at the maximum pumping rate, or a simple curve is needed to predict an optimum rate or specific capacity at some rate not used during the test. (USBR)
W69-05813

AQUIFER STORAGE DETERMINATION BY RADIOTRACER TECHNIQUES,
Federal Water Pollution Control Administration, Ada, Okla.
For primary bibliographic entry see Field 07B.
W69-05814

GROUNDWATER MANAGEMENT FOR THE NATION'S FUTURE--COMPUTER SIMULATION OF GROUNDWATER BASINS,
International Business Machines Corp., Los Angeles, Calif.; and California State Dept. of Water Resources, Los Angeles.
Howell N. Tyson, Jr., and Ernest M. Weber.
Proc, Amer Soc Civil Eng, Vol 90, No HY4, pp 59-77, July 1964. 19 p, 9 fig, 15 ref, 1 append.

Descriptors: *Simulation analysis, *Groundwater basins, *Analog computers, *Digital computers, Hydrologic data, Mathematical models, Water management (Applied), Water level fluctuations, Groundwater recharge, Groundwater mining.
Identifiers: Differential equations.

A mathematical model of a groundwater basin, representing its storage and transmissive characteristics, was developed and tested using general purpose analog and digital computers. The model permitted predictions of water level responses to extraction and recharge activities. Geologic and hydrologic data were collected, analyzed, and reduced for use in the computer simulation. A model of an aquifer system was developed that led to the diffusion equation in two dimensions. The diffusion model was approximated by a system of difference-differential equations defined by a set of asymmetrically-spaced node points. The procedure was extended to handle certain nonlinear features. It was concluded that analog computers were advantageous in the modeling phase, while digital computers were best suited for operational analysis of the model. (Gysi-Cornell)
W69-05864

RIVER WATER QUALITY FOR ARTIFICIAL RECHARGE,
Nebraska Univ., Lincoln. Dept. of Civil Engineering.
For primary bibliographic entry see Field 05B.
W69-05894

A CHANGE OF GROUNDWATER REGIME AS A METHOD OF CONTROLLING THE INCURSIONS OF SEA WATER (RUSSIAN),
Akademiya Nauk SSSR, Moscow. Council on the Problems of Water Economy.
N. N. Favorin.
In 'Invest of Surface and Underground Runoff', (Issledovaniye Poverkhnostnogo i Podzemnogo Stoka), Moscow, 'Nauka', pp 101-115, 1967. 15 p, 7 fig, 7 ref.

Descriptors: *Groundwater, *Groundwater basin, *Sea water, *Groundwater movement, Water pollution sources, Water quality control, Water supply, Water wells, Water yield improvement, Water balance, Water chemistry, Infiltration, Water levels, Water works, Dams, California.
Identifiers: *Estonia, USSR, Sea water incursion controls.

The methods of controlling incursions of sea water into fresh groundwater reservoirs were investigated on the basis of earlier investigations the results of which were published in the USSR (2 publications) and abroad (5 publications). An analysis of available information shows that the following procedures may be effective in controlling sea water incursions: (1) conservation of groundwater levels by decreasing the amounts of withdrawals by wells; (2) artificial replenishment of groundwater; (3) setting and maintaining a water barrier or a knoll of fresh groundwater at a certain definite level along the sea coast; (4) the formation of a depression crater of groundwater along the sea coast to be used as a reservoir for the infiltration of sea water; and (5) the construction of an underground dam to impede the movements of sea water within the coastal strip. (Gabriel-USGS)
W69-05939

DI GIACINTO V NEW JERSEY ZINC COMPANY (DIVERSION OF SUBTERRANEAN WATERCOURSE).

26 Lehigh County Law Journal 247-252 (CP Pa 1955).

Descriptors: *Underground streams, *Percolating water, *Diversion structures, *Pennsylvania, Hydraulic structures, Bypasses, Streams, Legal aspects, Judicial decisions, Mining, Mine water, Mine drainage, Competing use, Relative rights, Damages, Stream flow.

Plaintiff brought this action in trespass, alleging that defendant mining company pumped 24 million gallons of water per day out of a subterranean stream which previously fed plaintiff's well. Plaintiff also alleged that the defendant did not use this water but diverted it to a nearby creek. Defendant stated, by way of answer, that one engaged in mining has an absolute right to deal as he pleases with any water found on his premises. The court pointed out that the test used to determine liability for interference with a neighbor's watercourse is whether a possessor of the land destroyed the water supply in the use of his land for a lawful purpose, not whether the owner is consuming the water which has been cut off, diverted, or polluted. The court noted that the rule concerning watercourse destruction provides that such destruction is actionable if done with malice or negligence or if avoidable by a reasonable expenditure of cary and money. Defendant's demurrer was sustained. (Katz-Fla)
W69-05975

GOWING V LEHMANN (WATER USE EASEMENT).
For primary bibliographic entry see Field 06E.
W69-05985

4C. Effects on Water of Man's Non-Water Activities

SURVEY OF WATER INDUCED LAND-INSTABILITY HAZARDS IN THE PORTLAND, OREGON REGION,
Portland State Coll., Oreg. Dept. of Earth Science; and Oregon State Univ., Corvallis.
For primary bibliographic entry see Field 08D.
W69-05640

COMMENTS ON WATER TRANSFERS AND RELATED URBAN PROBLEMS,
Idaho Univ., Moscow. Dept. of Hydrology.
For primary bibliographic entry see Field 06D.
W69-05766

4D. Watershed Protection

CRITERIA FOR DESIGNING AND LOCATING LOGGING ROADS TO CONTROL SEDIMENT,
Forest Service (USDA), Logan, Utah. Intermountain Forest and Range Experiment Station.
Paul E. Packer.
Forest Science, Volume 13, No 1 (March, 1967): 1-18.

Descriptors: *Water quality, *Erosion control, *Sediment control, *Roads, *Sediment transport, Water pollution, Water supply, Soil erosion, Roadbanks, Bank erosion, Bank protection, Slope protection, Rocky Mountain Region, Watersheds (Basins), Construction, Road design.
Identifiers: *Location, Logging (Forest).

A recently completed study developed criteria for the design, location, and construction of logging roads in the northern Rocky Mountains to prevent damage to the water resource and to conserve soil. Results reveal which characteristics of watersheds and of secondary logging roads influence erosion of road surfaces and movement of sediment downslope from roads. They define the manner and degree in which these characteristics affect road-surface erosion and sediment movement, and they indicate which characteristics are controllable or alterable by design, management, or choice. They also provide the quantitative criteria needed to develop road design and location requirements that should be considered in planning and executing timber harvest operations, so that soil and water resources will be protected.
W69-05884

FOREST TREATMENT EFFECTS ON WATER QUALITY,
Forest Service (USDA), Logan, Utah. Intermountain Forest and Range Experiment Station.
Paul E. Packer.
Proceedings, International Symposium on Forest Hydrology, 687-699, Pergamon Press, Oxford, England. 1967.

Descriptors: *Water quality control, *Drainage systems, *Vegetation effects, *Soil erosion, Water demand, Running waters, Environmental effects, Sediment transport, Forest management, Lumbering, Clear-cutting, Bank erosion, Streamflow, Reforestation, Vegetation regrowth.
Identifiers: *Undisturbed forest, *Disturbed forest, Water damage, Disturbance of soil, Logging (Forest).

Most water flowing in our streams comes from forested watersheds. With continually increasing demands for high-quality water, we need to know how forest management activities affect the quality of water supplies. As the gentler forest lands become used more intensively, and as timber harvest activities extend further into rugged terrain, the opportunities for damage to water quality increase as a result of destruction of vegetation and disturbance of soil. Research to determine the affects on water quality of forest treatment associated with timber harvesting has shown that: (1) undisturbed forests produce only small amounts of sediment and a streamflow usually suitable for drinking; (2) with the possible exceptions of substantial increases in streamflow temperatures and some increases in streambank erosion caused by higher streamflow peaks, timber cutting does not adversely affect water quality; (3) logging, or skidding of logs from forests, can sometimes increase sedimentation considerably, depending upon the location and drainage of skidways, the erodibility and stoniness of soils, and the rapidity of revegetation of skidways; (4) roadx that are inadequately drained or are located too close to streams are the main cause of deterioration of water quality in forests. This article contains 35 references.
W69-05885

THE INFLUENCE OF ROADS ON WATER QUALITY CHARACTERISTICS,
Forest Service (USDA), Logan, Utah. Intermountain Forest and Range Experiment Station.
Paul E. Packer, and Harold F. Haupt.
Proceedings, Society of American Foresters, Detroit, Michigan, 1965 (1966): 112-115.

Descriptors: *Water quality, *Road design, *Sediment control, *Soil erosion, *Drainage practices, Access routes, Impaired water quality, Water resources, Drainage systems, Channel flow, Safe yield, Turbidity currents, Fish reproduction, Infiltration, *Water quality control, Overland flow.
Identifiers: *Road location, Water damage, Clean streams.

Road systems needed to serve interregional traffic as well as local uses, including those for timber harvesting, increase the potential for damaging the high quality of water. Examples are cited where poorly-built roads produce large amounts of sediment. Well-built forest roads contribute some sediment after construction; but, because of good location and design characteristics with respect to drainage, erosion scars heal rapidly. The importance of keeping even small quantities of sediment out of stream channels has been stressed repeatedly by fishery biologists. Turbid streamflow may drastically reduce aquatic fauna and the hatchability of fish eggs. Watershed scientists have observed that, when well-constructed roads are located some distance from streams, muddy overland flow does not reach the stream, but infiltrates harmlessly into the undisturbed intervening protective strip. Road location, drainage design, and nature of the protective strip, therefore, are essential factors in water-quality control on managed forest lands. Guides for locating and draining roads have been developed from investigations in specific locations where soil and terrain factors were studied. Similar study techniques would be valuable for determining the influence of roads on water quality characteristics under other conditions of soil and terrain. This article has 17 references.
W69-05886

EFFECTS OF SEEDING AND GRAZING ON INFILTRATION CAPACITY AND SOIL STABILITY OF A SUBALPINE RANGE IN CENTRAL UTAH,
Forest Service (USDA), Logan, Utah. Intermountain Forest and Range Experiment Station.
Richard O. Meeuwig.
Journal of Range Management, Volume 18, No 4, (1965): 173-180.

Descriptors: *Grazing, *Soil stability, *Soil properties, *Permeability, *Vegetation effects, Seed treatment, Cultivation, Density, Physical properties, Water properties, Percolation, Plants, Planting management, *Compaction, Range management, Organic matter.
Identifiers: *Treatment effects, *Cover density, Rangelands.

Seven years after disking and seeding to grass, the main effects of seeding and moderate grazing on infiltration and soil stability were: decreased plant and litter cover, decreased soil organic matter and capillary porosity, and greater bulk density. Infiltration capacity and soil stability were not significantly affected by the seeding treatment. Cattle grazing during the previous four years decreased plant and litter cover and noncapillary porosity of the surface soil. Both infiltration capacity and soil stability were decreased by grazing. Results of this study on soils that are predominantly silty clay loams derived from limestone and shale indicate that infiltration capacity is influenced primarily by soil bulk density and noncapillary porosity and secondarily by the amount of protective cover afforded by plants, litter, and stone. Soil stability is influenced primarily by the density of protective cover and secondarily by soil bulk density. (Packer-Forest Service)
W69-05889

05. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification of Pollutants

DETERMINATION AND ISOTOPE-RATIO ANALYSIS OF DIFFERENT FORMS OF NITROGEN IN SOILS: 6. MINERALIZABLE NITROGEN,
Iowa State Univ., Ames. Dept. of Agronomy.
D. R. Keeney, and J. M. Bremner.
Soil Sci Soc Amer Proc, Vol 31, No 1, pp 34-39, Jan-Feb 1967. 10 tab, 16 ref.

Descriptors: *Analytical techniques, *Water chemistry, *Nitrogen compounds, Cycling nutrients, Eutrophication, Soils, Sediments, Stable isotopes, Water pollution sources, Nutrients, Ammonium, Nitrate, Nitrite.
Identifiers: *Isotope-ratio analysis, *Exchangeable ammonium-nitrogen, *Nitrate-nitrogen, *Nitrite-nitrogen, Mineralizable nitrogen, Incubation method.

An incubation method for estimating mineralizable soil nitrogen is described. The method involves determination of nitrogen as the sum of exchangeable ammonium, nitrite, and nitrate produced when 10 g of soil mixed with 30 g of sand and 6 ml of water are incubated for 14 days at 30 deg C. Incubation conditions must ensure adequate aeration without loss of water. The method is based on the fact that the amount of water required for maximal aerobic mineralization of nitrogen is the same for all soils if the sample is just mixed with three times its weight of quartz sand (30 to 60 mesh). The method was compared to five other incubation methods (three of the methods measure only nitrate-nitrogen produced), and the results were found to be highly correlated to methods in which ammonium-nitrogen and nitrate-nitrogen are measured. Correlation was high between all methods for soils in which only nitrate-nitrogen was produced. (Konrad-Wis)
W69-05699

DETERMINATION AND ISOTOPE-RATIO ANALYSIS OF DIFFERENT FORMS OF NITROGEN IN SOILS: 3. EXCHANGEABLE AMMONIUM, NITRATE, AND NITRITE BY EXTRACTION-DISTILLATION METHODS,
Iowa State Univ., Ames. Dept. of Agronomy.
J. M. Bremner, and D. R. Keeney.
Soil Sci Soc Amer Proc, Vol 30, No 5, pp 577-582, Sept-Oct 1966. 9 tab, 10 ref.

Descriptors: *Nitrites, *Nitrates, *Analytical techniques, *Water chemistry, *Nitrogen compounds, Eutrophication, Soils, Sediments, Water pollution sources, Nutrients.
Identifiers: *Ammonium, Nitrogen forms, Steam-distillation method.

Methods for determination of exchangeable ammonium, nitrate and nitrite in soils are described. The sample is extracted with 2M potassium chloride and analyzed by steam distillation methods. The extract is treated with magnesium oxide for distillation of ammonium, ball-milled Devarda alloy for reduction of nitrate and nitrite to ammonium and sulfamic acid for destruction of nitrite. The methods gave quantitative recovery of ammonium, nitrate and nitrite added to soil extracts and were applicable to turbid, colored, and unfiltered extracts. (Konrad-Wis)
W69-05700

DETERMINATION AND ISOTOPE-RATIO ANALYSIS OF DIFFERENT FORMS OF NITROGEN IN SOILS: 4. EXCHANGEABLE AMMONIUM, NITRATE, AND NITRITE BY DIRECT-DISTILLATION METHODS,
Iowa State Univ., Ames. Dept. of Agronomy.
D. R. Kenney, and J. M. Bremner.

Soil Sci Soc Amer Proc, Vol 30, No 5, pp 583-587, Sept-Oct 1966. 8 tab, 12 ref.

Descriptors: *Analytical techniques, *Water chemistry, *Nitrogen compounds, Cycling nutrients, Stable isotopes, Eutrophication, Soils, Sediments, Water pollution sources, Nutrients, Ammonium, Nitrate, Nitrite.
Identifiers: *Isotope-ratio analysis, *Steam distillation method.

Methods of determining exchangeable ammonium, nitrate, and nitrite in soils which do not require extraction of the soil sample are described. The soil sample is treated with 2M potassium chloride (5 milliliters/gram of soil) and analyzed directly by steam-distillation methods involving use of magnesium oxide for liberation of ammonium, ball-milled Devarda alloy for reduction of nitrate and nitrite to ammonium, and sulfamic acid for reduction of nitrite. The methods are rapid, specific, and precise, and they permit nitrogen isotoperatio analysis of exchangeable ammonium, nitrate, and nitrite in nitrogen (N-15) tracer studies of nitrogen transformation in soils. Results of soil analyses by these direct distillation methods are practically identical to those obtained by extraction-distillation methods. (Keeney-Wis)
W69-05701

CHARACTERIZATION OF MINERALIZABLE NITROGEN IN SOILS,
Iowa State Univ., Ames. Dept. of Agronomy.
D. R. Keeney, and J. M. Bremner.
Soil Sci Soc Amer Proc, Vol 30, No 6, pp 714-719, Nov-Dec 1966. 7 tab, 18 ref.

Descriptors: *Nitrogen compounds, *Chemical analysis, *Soils, Analytical techniques, Water chemistry, Eutrophication, Cycling nutrients, Sediments, Water pollution sources, Nutrients.
Identifiers: *Mineralizable nitrogen, Nitrogen availability, Fixed ammonium nitrogen, Hydrolyzable nitrogen, Non-hydrolyzable nitrogen.

Incubation conditions which promoted mineralization of soil nitrogen showed that prolonged incubation resulted in a decrease in total nitrogen and hydrolyzable and non-hydrolyzable forms of nitrogen. No decrease was found in fixed ammonium-nitrogen indicating that fixed ammonium-nitrogen is practically unavailable to microorganisms. Studies of 26 soils showed marked differences among soils with regard to the nature of the nitrogen that is most readily mineralized and made available for plant growth and also indicated that any chemical method of obtaining an index of soil nitrogen availability based on determination of a hydrolyzable or non-hydrolyzable form of soil nitrogen will prove unsatisfactory. (Konrad-Wis)
W69-05703

STEAM DISTILLATION METHODS FOR DETERMINATION OF AMMONIUM, NITRATE AND NITRITE,
Iowa State Univ., Ames. Dept. of Agronomy.
J. M. Bremner, and D. R. Kenney.
Anal Chim Acta, Vol 32, pp 485-495, 1965. 2 fig, 6 tab, 20 ref.

Descriptors: *Steam-distillation method, *Analytical techniques, *Nitrogen compounds, *Ammonia, *Nitrates, *Nitrites, Nitrogen forms, Ammonium compounds.

Steam distillation methods for determining ammonium-nitrogen, nitrate-nitrogen are described, along with the steam distillation apparatus used. The methods involve use of magnesium oxide for distillation of ammonium, ball-milled Davarda alloy for reduction of nitrate and nitrite to ammonium and sulfuric acid for destruction of nitrite. The methods gave quantitative recovery of ammonium, ammonia and nitrite added to soil and plant extracts, and they are rapid, accurate and precise. (Konrad-Wis)
W69-05709

A STUDY OF GROUNDWATER CONTAMINATION DUE TO SALINE WATER DISPOSAL IN THE MORROW COUNTY OIL FIELDS,
Ohio State Univ., Columbus. Dept. of Geology.
For primary bibliographic entry see Field 05B.
W69-05749

DETERMINATION AND ISOTOPE-RATIO ANALYSIS OF DIFFERENT FORMS OF NITROGEN IN SOILS: 7. UREA,
Iowa State Univ., Ames. Dept. of Agronomy.
D. R. Keeney, and J. M. Bremner.
Soil Sci Soc Amer Proc, Vol 31, No 3, pp 317-321, May-June 1967. 7 fig, 1 tab, 7 ref.

Descriptors: *Analytical techniques, *Soil chemistry, *Nitrogen compounds, Water chemistry, Eutrophication, Enzymes, Cycling nutrients, Stable isotopes, Soils sediments, Water pollution sources, Ammonium, Nitrate, Nitrite, Chemical analysis.
Identifiers: *Isotope-ratio analysis, *Steam distillation methods, *Extraction-distillation methods, *Direct-distillation methods, Urease, Urea-nitrogen, Chemical transformations.

Two methods of determining urea in soils are described. In one (extraction-distillation method), soil samples are extracted with potassium chloride (2 Molar) (10 milliliters/gram of soil) for 5 minutes, and an aliquot of the extract is treated with potassium phosphate buffer (pH 8.00) and urease for two hours at 30 deg Celsius to convert urea-nitrogen to ammonium-nitrogen. In the other (direct-distillation method), soil sample is treated directly with potassium phosphate buffer (pH 8.0) and urease for one hour at 30 deg Celsius. In both, ammonium released by urease treatment is separated by steam distillation of the treated sample for 3.3 minutes and determined by titration of distillate with standard acid. Extraction-distillation method is useful when analyses for nitrate and nitrite as well as urea are required, but it does not give completely quantitative recovery of urea added to some soils. Methods are rapid, specific and precise, and they permit isotope-ratio analysis of urea-nitrogen in tracer (N-15) studies of urea transformation in soils. (Keeney-Wisc)
W69-05872

USE OF THE COLEMAN MODEL 29A ANALYZER FOR TOTAL NITROGEN ANALYSIS OF SOILS,
Iowa State Univ., Ames.
D. R. Keeney, and J. M. Bremner.
Soil Sci, Vol 104, No 5, pp 358-363, 1967. 5 tab, 17 ref.

Descriptors: *Chemical analysis, *Nitrogen, *Soil analysis, Analytical techniques, Ammonium compounds, Eutrophication, Nitrates, Nitrites, Organic soils, Nitrogen compounds, Nutrients, Soils, Sediments, Water chemistry, Water pollution sources.
Identifiers: *Coleman nitrogen analyzer, *Dumas procedure, Kjeldahl procedure, Mineral soils.

Studies to evaluate an automated Dumas procedure (Coleman Model 29A Nitrogen Analyzer) for determination of total soil nitrogen showed that maximal total nitrogen values were obtained by a procedure involving combustion of soil mixed with wire-form copper oxide-platinum catalyst at 940 deg Celsius for 12.6 minutes in a tube filled with this catalyst. This procedure permitted analysis of up to 3 grams of mineral soil containing up to 0.4 milliliter of water and gave almost quantitative recovery of nitrate-nitrogen and nitrite-nitrogen added to soil. A comparison of the results obtained in total nitrogen analysis of soils by this Dumas procedure and by Kjeldahl and HF-Kjeldahl techniques showed that, when applied to surface samples of mineral and organic soils, these methods gave practically identical results, whereas their results with two subsoils containing large amounts of fixed ammonium were in the order: HF-Kjeldahl greater than Dumas greater than Kjeldahl. The findings reported indicate that total nitrogen in most soils can be determined satisfactorily by Dumas or Kjeldahl methods but that these methods do not give complete recovery of native fixed ammonium-nitrogen in some soils containing high levels of fixed nitrogen. (Keeney-Wisc)
W69-05874

A SIMPLE STEAM DISTILLATION METHOD OF ESTIMATING (BETA-HYDROXY-ALPHA-AMINO) ACIDS,
Iowa State Univ., Ames. Dept. of Agronomy.
D. R. Keeney, and J. M. Bremner.
Analytical Biochemistry, Vol 18, No 2, pp 274-285, Feb 1967. 1 fig, 5 tab, 15 ref.

Descriptors: *Amino acids, *Soil analysis, *Soil chemistry, Ammonium compounds, Analytical techniques, Chemical analysis, Cycling nutrients, Eutrophication, Nitrogen compounds, Nutrients, Sediments, Soils, Water chemistry, Water pollution sources.
Identifiers: *Beta-hydroxy-alpha-amino acids, *Steam distillation methods, Serine, Threonine.

A simple method of estimating beta-hydroxy-alpha-amino acids from ammonium released by their reaction with alkaline periodate is described. This involves steam distillation with phosphate-borate buffer (pH 11.2) before and after treatments with periodic acid (to oxidize beta-hydroxy-alpha-amino-nitrogen to ammonium-nitrogen) and with sodium arsenite (to reduce excess periodate). Ammonium liberated by second distillation can be determined by titration of distillate with standard acid. Method is rapid and precise and gives quantitative results with serine, threonine, and other beta-hydroxy-alpha-amino acids. When applied to protein hydrolysates, results closely agree with those obtained by periodate method of estimating similar amino acids proposed by Van Slyke, Hiller, and MacFadyen. (Keeney-Wisc)
W69-05875

POTOMAC RIVER WATER QUALITY NETWORK, 1968 WATER YEAR.
Interstate Commission on the Potomac River Basin, Washington, D. C.
For primary bibliographic entry see Field 05B.
W69-05920

QUALITY STANDARDS FOR NATURAL WATERS,
For primary bibliographic entry see Field 05G.
W69-05934

5B. Sources of Pollution

THE EFFECTS OF BENDS ON DISPERSION IN STREAMS,
California Univ., Berkeley.
For primary bibliographic entry see Field 02E.
W69-05609

BACTERIAL ORIGIN OF SULFURIC ACID IN SULFUROUS HOT SPRINGS,
Geological Survey, Menlo Park, Calif.
For primary bibliographic entry see Field 02K.
W69-05654

RECOMMENDATIONS FOR WATER POLLUTION CONTROL IN RACCOON CREEK BASIN, OHIO.
Federal Water Pollution Control Administration, Washington, D. C.
For primary bibliographic entry see Field 05G.
W69-05661

EFFECT OF CULTIVATION ON THE NITROGEN DISTRIBUTION IN SOILS,
Iowa State Univ., Ames. Dept. of Soils.
For primary bibliographic entry see Field 02K.
W69-05710

INORGANIC NITROGEN IN PRECIPITATION AND ATMOSPHERIC SEDIMENTS,
Hamilton Filtration Plant (Ontario).
DeLoss H. Matheson.
Can J Technol, Vol 19, pp 406-412, 1951. 4 tab, 7 ref.

Descriptors: *Nitrogen, *Precipitation, *Atmospheric sedimentation, Ammonia, Nitrate, Eutrophication, Cycling nutrients.

Daily determinations of the inorganic nitrogen (ammonium and nitrate) contained in precipitation and atmospheric sediments were made over a period of 18 months. The total nitrogen fall was 5.8 lb/acre/year with 61% of the total falling on 25% of the days when precipitation occurred. The remaining 40% of the total nitrogen fell on days of no precipitation and was attributed to inorganic nitrogen associated with atmospheric dust. The inorganic nitrogen precipitated during the entire period averaged 56% nitrate-nitrogen; however, individual samples varied widely from day to day. In general, the nitrogen concentration of short storms was higher than prolonged storms. This may result in a lower nitrogen fall per day than will be the case with shorter, more intense storms. (Konrad-Wis)
W69-05712

A STUDY OF GROUNDWATER CONTAMINATION DUE TO SALINE WATER DISPOSAL IN THE MORROW COUNTY OIL FIELDS,
Ohio State Univ., Columbus. Dept. of Geology.
Jay H. Lehr.
Research Project Completion Report, Water Resources Center, March, 1969. 81 p, 10 tab, 16 fig, 2 ref. OWRR Project A-004-OHIO.

Descriptors: *Saline water, Groundwater recharge, Oil wastes, Brine disposal, Chlorides, Water pollution.
Identifiers: *Oil field wastes, Evaporation pits, *Groundwater contamination.

The purpose was to study the effects of pollution of ground water in Morrow and Delaware Counties, Ohio, due to the introduction of saline oil field wastes through evaporation pits. The investigation was directed toward the determination of the source, severity, areal extent, and probable future movement of the pollution. It was found that contaminated ground water tends to move as slug rather than mixing with contacting fresh waters. The shallow levels of the reservoir carried the bulk of the contamination at first, but with time and continued salt-water introduction through the pits, inversion occurred, and the deeper levels became more contaminated. Resistivity studies have indicated soil contamination in the zone of aeration which shows that ion-exchange phenomena may greatly extend the time period required for natural clearing of saline enclaves. The addition of resistivity and conductivity techniques to supplement chloride analysis was successful in this study. The use of unlined evaporation pits in humid areas where fresh ground water may be contaminated by brines should be prohibited by state legislation.
W69-05749

WATER QUALITY IN HAWAII,
Hawaii Univ., Honolulu. School of Public Health.
For primary bibliographic entry see Field 05G.
W69-05893

RIVER WATER QUALITY FOR ARTIFICIAL RECHARGE,
Nebraska Univ., Lincoln. Dept. of Civil Engineering.
Leon S. Directo, and Merlin E. Lindahl.
J Amer Water Works Ass, Vol 61, No 4, pp 175-180, Apr 1969. 6 p, 8 fig, 1 tab, 8 ref. Res supported by Nebr Univ. Water Resources Center.

Descriptors: *Water quality, *Artificial recharge, *Data collections, Pit recharge, Water supply, Municipal water, Sediment load, Conductivity, Calcium, Magnesium, Alkalinity, Sulfates, Chlorides, Sodium, Iron, Dissolved soilds, Phosphates, Nitrogen, Algae, Coliforms.
Identifiers: Platte River, Lincoln (Nebr).

The Platte River was sampled in 1966-67 at 3 locations near Ashland, Nebraska to investigate seasonal variations in its physical, chemical, and biological qualities in a study of the feasibility of using the river water for recharge of the aquifer supplying the wells for the city of Lincoln. All the samples were taken using the equal transit rate method of depth integration. Streamflow data were obtained from USGS gaging station records. The mean specific conductance of 439 micromhos/cm was exceeded 60% of the time. The mean solids concentration was 1090 mg/1. This is expected to cause clogging problems in use of the water for recharge unless solids are removed. The sodium absorption ratio averaged 1.05 mg/1 and iron concentration 0.41 mg/1, neither of which should cause any problem. Phosphate concentration averaged 1.07 mg/1 with an algae count of 910, which could result in heavy algal growth on sand recharge beds. Coliform density was 6,610/100 ml at Ashland. All the collected data, including temperature, pH, alkalinity, and hardness are shown graphically. River water is similar in chemical quality to the groundwater in the well field, and should cause no compatibility problems. The high solids, algae, and coliform concentrations may cause clogging. (Knapp-USGS)
W69-05894

HYDROGEOLOGIC DATA FROM FOUR LANDFILLS IN NORTHEASTERN ILLINOIS,
Illinois State Geological Survey, Urbana.
For primary bibliographic entry see Field 07C.
W69-05896

MICROBIAL SULFATE REDUCTION AND ITS POTENTIAL UTILITY AS AN ACID MINE WATER POLLUTION ABATEMENT PROCEDURE,
Ohio State Univ., Columbus. Dept. of Microbial and Cellular Biology.
For primary bibliographic entry see Field 05G.
W69-05898

MICROBIAL DISSIMILATORY SULFUR CYCLE IN ACID MINE WATER,
Ohio State Univ., Columbus. Dept. of Microbial and Cellular Biology.
Jon H. Tuttle, Patrick R. Dugan, Carol B. Macmillan, and Chester I. Randles.
J Bacterial, Vol 97, No 2, pp 594-602, Feb 1969. 9 p, 6 fig, 4 tab, 20 ref. OWRR Grant No 14-01-0001-805,980.

Descriptors: *Reduction (Chemical), *Biodegradation, *Aquatic bacteria, *Acid mine water, Nutrients, Sawdust, Wood wastes, Fermentation, Aquatic microbiology.
Identifiers: Sulfate-reducing bacteria.

Heterotrophic microflora in and below a sawdust mass across a stream carrying acid mine drainage included dissimilatory sulfate-reducing bacteria which reduce sulfate to sulfide. The sawdust was the source of nutrients to allow enough sulfate-reducing bacteria growth to cause increase of pH downstream from the sawdust. Mixed cultures which included sulfate-reducing bacteria reduced sulfate at pH 3.0 in the laboratory with sawdust as the only nutrient, while pure cultures of sulfate-reducing bacteria could not reduce sulfate below pH 5.5. (Knapp-USGS)
W69-05899

TRAVEL OF SOLUTES IN THE LOWER MISSOURI RIVER,
Geological Survey, Washington, D. C.
J. E. Bowie, and L. R. Petri.
Geol Surv Hydrol Invest Atlas HA-332, 1 sheet, 1969. Text, 1 map, 9 chart, 1 tab, 5 ref.

Descriptors: *Path of pollutants, *Tracers, *Dye release, *Missouri River, Streamflow, Velocity, Dispersion, Diffusion, Adsorption, Fluorometry.
Identifiers: *Travel time (Missouri River).

The results of a dye-tracer study of the flow of the lower Missouri River are presented in a 1-sheet hydrological atlas consisting of text, index map of the river from Yankton, S. D. to St. Louis, Mo., charts, and tables. Travel times are calculated, tabulated, and shown by time-concentration graphs. The graphs may be used to estimate the dispersion and travel of any conservative contaminant. (Knapp-USGS)
W69-05909

POTOMAC RIVER WATER QUALITY NETWORK, 1968 WATER YEAR.
Interstate Commission on the Potomac River Basin, Washington, D. C.

Interstate Comm Data Compilation Rep, 1968. 29 p, 1 fig, 3 map, 1 chart.

Descriptors: *Water quality, *Rivers, Biochemical oxygen demand, Turbidity, Coliforms, Alkalinity, Hydrogen ion concentration, Water temperature, Streamflow, Dissolved oxygen, Suspended load, Dissolved solids, Water pollution effects, Standards, Pennsylvania, Maryland, Virginia, West Virginia, District of Columbia.
Identifiers: *Potomac River Basin.

Water quality data are compiled for the Potomac River basin for the 1968 water year. Data were obtained from 79 stream sampling stations. Standard analyses include streamflow, water temperature, turbidity, alkalinity, pH, dissolved oxygen, saturation (%), BOD, coliforms, total bacteria, suspended solids, and total solids. (Knapp-USGS)
W69-05920

QUALITY STANDARDS FOR NATURAL WATERS,
For primary bibliographic entry see Field 05G.
W69-05934

5C. Effects of Pollution

IMPOUNDMENT AND TEMPERATURE EFFECT ON WASTE ASSIMILATION,
Vanderbilt Univ., Nashville, Tenn. Dept. of Sanitary and Water Resources Engineering.
Peter A. Krenkel, Edward L. Thackston, and Frank L. Parker.
ASCE Proc, J Sanit Eng Div, Vol 95, No SA1, Pap 6406, pp 37-64, Feb 1969. 28 p, 11 fig, 3 tab, 56 ref. Grant No WPD-168-01-67.

Descriptors: *Waste assimilative capacity, *Reservoirs, *Impoundments, Thermal stratification, Biochemical oxygen demand, Dissolved oxygen, Reaeration, Path of pollutants, Water temperature, Photosynthetic oxygen, Oxygen sag. Water pollution.
Identifiers: *Impoundment effects.

The waste assimilative capacity of streams can be greatly affected by changes in temperature and hydraulic regime caused by impoundment. The increase in depth and decrease in mixing reduce atmospheric oxygenation but provide a more favorable environment for photosynthetic oxygenation. While surface layers remain well aerated, benthal demands and sedimentation of organic material may deoxygenate the lower waters. This effect is accentuated by thermal stratification. The effect of impoundment on all phases of the oxygen balance is considered. References and case studies show that the net effect can be a greatly reduced capacity for waste assimilation. (Knapp-USGS)
W69-05637

REAERATION PREDICTION IN NATURAL STREAMS,
Vanderbilt Univ., Nashville, Tenn. Dept. of Sanitary and Water Resources Engineering.

Edward L. Thackston, and Peter A. Krenkel.
ASCE Proc, J Sanit Eng Div, Vol 95, No SA1, Pap 6407, pp 65-94, Feb 1969. 30 p, 13 fig, 4 tab, 34 ref, append.

Descriptors: *Reaeration, *Streams, Diffusion, Mass transfer, Mixing, Open channel flow, Turbulence, Aeration, Oxygenation, Water circulation.
Identifiers: *Stream reaeration prediction.

The reaeration coefficient can be shown to be proportional to the vertical mass transfer coefficient at the surface and inversely proportional to the square of the average depth. The constant is evaluated from experimental data for various scales of flow and the resulting single equation is shown to have greater accuracy, cover a wider range of flow scales, and be less sensitive to variations in basic data than any of the presently used methods of prediction. (Knapp-USGS)
W69-05638

THE EFFECTS OF ALGAE ON WATER QUALITY,
Syracuse Univ., N. Y. Dept. of Civil Engineering.
Daniel F. Jackson.
Water Quality Res Symp, lst Proc, New York State Dept Health, Feb 20, 1964. 23 p, 5 fig, 2 tab, 53 ref.

Descriptors: *Algae, *Water quality, *Eutrophication, Color, Taste, Odor, Toxins, Dissolved oxygen, Lakes, Rivers, Light penetration, Fluorescence, Photosynthesis, Blue-green algae, Phytoplankton, Ohio River, Pennsylvania, Water supply.
Identifiers: Photosynthetic rate, Phytoplankton dynamics, Extracellular products, Algal cells.

Historical occurrences of colored water caused by algal growth are cited. Investigations (1797) revealed that Volvocales caused red water, with first recorded study on phytoplanktonic development (Oscillatoria) conducted by DeCandolle (1825). In Pymatuning Reservoir, Pennsylvania, cyanophytes bloom annually, restricting light penetration to less than 46 cm during July and August, retarding growth of rooted aquatic plants, and exposing bottom soil to wave-action erosion and consequent suspension of nutrient-rich materials. Tabular data on odors and tastes are discussed. Author determined percentage of viable cells to validate common assumption that degree of odor is associated with quantity of algal cells. Average viable fraction for 1,700 measurements on Ohio River samples (1960-61) was 59%; measurements were based on chlorophyll fluorescence. Dead algal cells, which create odors and taste, should be determined in plankton algae studies. Discussion of algal contribution to dissolved oxygen indicates that each species has its own minimum/maximum photosynthetic rate influenced by environment, and total oxygen production follows a phylogenetic hierarchy. Literature review and experiments show that algae contribute significant amounts of dissolved oxygen. Author's review of algal excretion and secretion includes discussion of toxins. He discusses theoretical equation to evaluate phytoplankton dynamics reported by Riley and Von Arx (1949). (Kerrigan-Wis)
W69-05697

RUSSIAN RADIOECOLOGY, A BIBLIOGRAPHY OF SOVIET PUBLICATIONS WITH CITATIONS OF ENGLISH TRANSLATIONS AND ABSTRACTS,
Nevada Operations Office (AEC), Las Vegas.
Alfred W. Klement, Jr., Charles F. Lytle, and Vincent Schultz.
Sept 1968, 131 p, TID-3915.

Descriptors: *Radioecology, *Bibliographies, Abstracts, Cycling nutrients, Ecosytems, Radioactivity, Radioactivity effects, Radioisotopes, Translations, Water pollution effects, Water pollution sources.
Identifiers: *Soviet Russia, Radioactive uptake, Freshwater environments, Marine environments, Terrestrial environments.

Active efforts of Soviet scientists in the field of radioecology during recent years have resulted in a rapidly expanding body of literature, much of which is neither well known nor readily accessible to many American scientists. In this bibliography of 1340 entries, compilers attempted to bring together a comprehensive listing of this material, indicating those papers for which English translations are known to exist. For this bibliography they adopted a broad working definition of radioecology to include research dealing with distribution, effects, and utilization of radionuclides in freshwater, marine, and terrestrial environments; ecological techniques employing radionuclides; and laboratory studies (particularly those dealing with wild species of plants and aninals) which appear to have either direct or indirect ecological implications. References to English abstracts generally available in American technical libraries are given in most cases. Citations cover the period from 1916 to 1968, of which some 910 appeared in the period 1960-1968. Report includes appendices comprising list of abbreviations and report number prefixes, list of Soviet journals being translated cover-to-cover, and a list of Russian acronyms. (Eichhorn-Wis)
W69-05708

A FIELD AND LABORATORY STUDY OF FLUORIDE UPTAKE BY OYSTERS,
North Carolina State Univ., Raleigh. Dept. of Zoology.
David J. Moore.
North Carolina Univ WRRI Report, March 15, 1969. 13 p, 2 fig, 5 ref. OWRR Project A-030-NC.

Descriptors: *Oysters, *Fluorides.
Identifiers: Fluoride uptake rate, Fluoride concentration, Fluoride tissue, Water fluoride levels.

The uptake and concentration of fluoride in the tissues of oysters was studied under laboratory conditions. Experimental animals were maintained for up to two months in water fluoride levels of 0.5, 2, 8, 32, and 128 ppm using fluoride free artificial sea water containing specific amounts of sodium fluoride. Tissue fluoride analyses were made at intervals throughout the experiment and the fluoride uptake rates were determined. It was found that oysters did accumulate fluoride at all of the experimental fluoride concentrations except 0.5 ppm which is within the range of natural water fluoride levels. Maximum uptake occurred during the first five days of exposure and was followed by an abrupt decrease in the accumulation rate throughout the remainder of the study period. Tissue fluoride levels as high as 100 ppm (dry weight basis) were observed in oysters from 32 ppm water; 30 ppm from 8 ppm water; and 18 ppm from 2 ppm water. Oysters with these higher tissue fluoride concentrations, e.g., 100 and 30 ppm, are believed to represent a potential public health problem if they are consumed in large amounts by the general public. Difficulty was encountered in maintaining oysters for longer than 30 days at 32 ppm and for longer than five days at 128 ppm water fluoride. This indicates that prolonged exposure to water fluoride levels as low as 32 ppm will be disastrous to oyster populations in the affected area.
W69-05752

A PRELIMINARY REPORT OF THE FOSSIL DIATOM FLORA FROM LAKE HURON SEDIMENTS,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
For primary bibliographic entry see Field 02H.
W69-05762

NEARSHORE PHYTOPLANKTON POPULATIONS IN THE GRAND HAVEN, MICHIGAN VICINITY DURING THERMAL BAR CONDITIONS,
Michigan Univ., Ann Arbor. Great Lakes Research Div.
For primary bibliographic entry see Field 02H.
W69-05763

INFLUENCE OF CHRONIC EXPOSURE TO ANIONIC DETERGENTS ON TOXICITY OF PESTICIDES TO GOLDFISH,
Ohio State Univ., Columbus.
Patrick R. Dugan.
J. Water Poll. Contr. Fed., Vol 39, No 1, pp 63-71, Jan 1967. 9 p, 9 fig, 1 tab, 11 ref.

Descriptors: *Pesticides, *Toxicity, *Detergents, Chronic toxicity effects, Water pollution, *Fish mortality, Environmental effects, Synergistic influence.
Identifiers: Pesticide toxicity, Chlorinated hydrocarbons.

Goldfish with a history of exposure to sub-lethal concentrations of alkyl benzene sulfonate (ABS) detergent are more susceptible to the toxic effects of either DDT or dieldrin than control fish which do not have a history of exposure to ABS.
W69-05768

GROWTH AND RESISTANCE TO STRESS IN BROOK TROUT FED SUBLETHAL LEVELS OF DDT,
Kenneth J. Macek.
J. Fish. Res. Bd. Canada, 1968. 25 (11): 2443-2451.

Descriptors: *Brook trout, Salmonoid, *DDT, Survival, Stress.
Identifiers: Brook trout growth, Resistance, Sublethal levels DDT.

When underyearling brook trout (Salvelinus fontinalis) were fed DDT at a rate of 2.0 mg/kg per week for 31 weeks, they exhibited greater weight gain (43.2 plus or minus 0.8 g) during the period than did untreated fish (36.6 plus or minus 1.1 g). When underyearling fish were fed DDT at different rates for 26 weeks and then starved or fed at a rate equivalent to 10% of the usual feeding rate, the cumulative mortality during this period was 96.2% among fish exposed to 3.0 mg/kg per week, 88.6% among fish exposed to 2.0 mg/kg per week, and 1.2% among untreated fish. Differences in the length of survival of DDT-exposed fish occurred due to dosage, sex, and type of starvation. The evidence suggests that the mortality of DDT-exposed fish was due to the interaction of DDT residues with a combination of environmental stresses, namely starvation, decreasing water temperature and possibly the physiological stress associated with the spawning season.
W69-05770

REPRODUCTION IN BROOK TROUT (SALVELINUS FONTINALIS) FED SUBLETHAL CONCENTRATIONS OF DDT,
Kenneth J. Macek.
J. Fish. Res. Bd. Canada, 1968. 25 (9): 1787-1796.

Descriptors: *Brook trout, Salmonoid, *DDT, Sac fry, Gametes.
Identifiers: Brook trout reproduction, Sublethal levels DDT.

When sexually maturing yearling brook trout were fed for 156 days with DDT at rates that evidently caused no mortality, fish fed at the lower dosages produced more mature ova than untreated fish. Those fed at the highest dosage produced fewer mature ova than untreated fish. The size of the male fish at the end of the feeding period tended to increase according to dosage of DDT. In eggs and sac fry obtained from various mating combinations of gametes from the experimental groups, mortality was with one exception higher when at least one of the gametes came from treated fish than when they both came from untreated fish. A major portion of the mortality of sac fry in groups where the eggs came from treated fish accurred during the 15th week of development. This period coincided with the period of maximum utilization of yolk fat reported to occur in other salmonid fry, and indicated that insecticide residues in the eggs were released at this time and resulted in the observed mortality. The residue concentrations in the fish at

the end of the feeding period were similar to those reported for wild fish.
W69-05771

DEATH OF A LAKE,
David C. Flaherty.
Quest, Vol 6, No 4, pp 6-15, Dec 1968. 10 p, 9 fig.

Descriptors: *Lakes, *Eutrophication, Fertilization, Fish, *Limnology, Fishkill, Nutrients, *Algae, *Algal control, Algal poisoning, Algicides, Aquatic algae, Aquatic environment, Aquatic plants, Aquatic populations, Conservation, Water quality, Water pollution, Water resources.
Identifiers: Algal nutrients.

The natural process of lake eutrophication is being accelerated by the activities of man. Sewage discharges, waste effluents, and agricultural fertilizers draining into a lake produce an overabundance of nutrients in the lake. The abundance of nutrients greatly stimulates the growth of algae and other water plants, but sets off a destructive chain reaction. At first, the abundant food chain will benefit the fish, but in severe cases, the algae may grow in such numbers that when they die, they deplete the oxygen supply and release toxic substances. The result may be a loss of a sparkling fresh lake, slime infestation, bad flavor and odor, discoloration of water, stagnation, and massive fishkill. Clean-water and polluted-water algae are described and methods for algae control are covered. Limnology studies at Williams Lake and Rock Lake, Wash, are discussed. Many bodies of water appear destined to die long before their natural time, producing an economic loss amounting to millions of dollars. The loss in aesthetic values of lakes cannot be measured. (USBR)
W69-05844

ARTIFICIALLY INDUCED CIRCULATION OF LAKES BY MEANS OF COMPRESSED AIR,
Wisconsin Univ., Madison. Dept. of Zoology.
William R. Schmitz, and Arthur D. Hasler.
Science, Vol 128, No 3331, pp 1088-1089, Oct 31, 1958. 1 fig, 9 ref.

Descriptors: *Lakes, *Mud, *Phosphorus radioisotopes, *Water circulation, Cycling nutrients, Phosphorus compounds, Phosphates, Eutrophication, Diffusion, Water chemistry, Sediment-water interface, Limnology, Thermal stratification, Aeration, Winterkilling, Wisconsin.
Identifiers: *Experimental limnology, Sawmill Pond (Wis), Tub Lake (Wis), Katharine Lake (Wis), Fish production, Temperate lakes, Lake management.

Turbulence induced by air bubbles causes circulation in small thermally stratified lakes. Tests were made under summer and winter (ice-cover) conditions. Homoisothermal conditions, isometric concentrations of phosphorus, and increases of dissolved oxygen were achieved, at various rates of treatment. The application of the technique for lake management and studies of lake dynamics is suggested. (Hasler-Wis)
W69-05866

AVAILABILITY OF IRON AND MANGANESE IN SOUTHERN WISCONSIN LAKES FOR THE GROWTH OF MICROCYSTIS AERUGINOSA,
Wisconsin Univ., Madison. Dept. of Botany.
Gerald C. Gerloff, and Folke Skoog.
Ecology, Vol 38, No 4, pp 551-556, Oct 1957. 7 tab, 10 ref.

Descriptors: *Eutrophication, *Iron, *Lakes, *Manganese, *Wisconsin, Algae, Calcium, Chelation, Cyanophyta, Nuisance algae, Nutrient requirements, Nutrients, Toxicity, Water chemistry, Water pollution effects.
Identifiers: *Nutrient availability, *Algal growth, *Microcystis aeruginosa, Antagonisms, Algal nutrition, Algal physiology, Lake Mendota (Wis), Lake Monona (Wis), Lake Waubesa (Wis), Spaulding Pond (Wis), Lake Delavan (Wis), Pewaukee Lake (Wis), North Lake (Wis), Lake Nagawicka (Wis).

Cellular contents were compared of iron and manganese in Microcystis aeruginosa, collected from blooms in seven southern Wisconsin lakes, with critical levels of these elements for maximum growth as determined in the laboratory. Critical levels were approximately 100 ppm iron and 4 ppm manganese. Range of algal iron content for lakes sampled was 164-543 ppm; manganese, 13-232 ppm. For 36 samples from eutrophic Lake Mendota collected at surface and at 10 and 0.5 meters above bottom at 12 dates during all seasons for one year, iron concentrations in water had range 0.000-0.083 ppm; manganese, 0.035-0.673 ppm. Cellular contents of iron and manganese were sufficiently in excess of such critical values that it seems unlikely that either is important in development of Microcystis blooms in lakes. Antagonistic relationships between manganese and iron and between calcium and manganese were demonstrated and contributed to difficulties in determining levels of iron and manganese required for nutrition. Such antagonisms were considered as insufficiently serious to significantly affect accuracy of their studies and conclusions derived therefrom. Manganese appears to attain concentrations in lake water sufficiently high to be toxic to algae were it not for antagonism of calcium, also present in relatively high concentrations. (Eichhorn-Wisc)
W69-05867

CELL CONTENTS OF NITROGEN AND PHOSPHORUS AS A MEASURE OF THEIR AVAILABILITY FOR GROWTH OF MICROCYSTIS AERUGINOSA,
Wisconsin Univ., Madison. Dept of Botany.
Gerald C. Gerloff, and Folke Skoog.
Ecology, Vol 35, No 3, pp 348-353, July 1954. 5 fig, 7 tab, 8 ref.

Descriptors: *Chemical analysis, *Nitrogen, *Phosphorus, Algae, Cyanophyta, Nitrates, Nitrogen compounds, Nuisance algae, Nutrient requirements, Nutrients, Phosphorus compounds, Water chemistry, Water pollution effects, Water quality, Wisconsin, Lakes, Eutrophication.
Identifiers: *Chemical composition, *Microcystis aeruginosa, *Nutrient availability, Algal growth, Algal nutrition, Algal physiology, Kjeldahl procedure, Luxury consumption, Nutrient removal, Spaulding's Pond (Wis), Lake Waubesa (Wis), Green Lake (Wis).

Quantitative relationships were studied between total nitrogen and phosphorus contents of Microcystis aeruginosa grown in nutrient solutions containing these elements in quantities varying from highly deficient to excessive. Cellular content of nitrogen or phosphorus increases with external supply over a wide range, for a major portion of which the amount of growth remained practically constant. Thus, above fairly constant critical levels of nitrogen and phosphorus required for maximum yield, large cellular excesses accumulated, representing luxury consumption. Although not influencing growth, these excesses reflect abundance of external supplies. Nitrogen and phosphorus contents of Microcystis collected from blooms in three Wisconsin lakes, when compared with cultures grown in laboratory, showed that cellular contents of these elements in collected samples were in range of luxury consumption and sufficiently above critical levels to suggest that neither phosphorus nor nitrogen limited algal growth in these lakes. Nitrogen occurred in relatively smaller excess than phosphorus. Cellular excesses were sufficient to permit considerable growth when algae were transferred to media deficient in these nutrients. Efficacy of phosphorus removal from cultural effluents may be doubtful unless levels are also much reduced, both in other inflowing water and in 'sinks' within lakes. (Eichhorn-Wisc)
W69-05868

A COMPARATIVE STUDY IN EUTROPHICATION,
Yale Univ., New Haven, Conn. Osborn Memorial Lab.
Ursula M. Cowgill.
Developments In Applied Spectroscopy, Vol 6, pp 299-321, 1968. 18 fig, 11 ref.

Descriptors: *Eutrophication, *Water chemistry, *Geochemistry, Calcium, Chemical composition, Connecticut, Cooper, Cycling nutrients, Density currents, Hydrogen sulfide, Hypolimnion, Epilimnion, Ice, Iron, Lakes, Limnology, Magnesium, Manganese, Oxygen, Phosphorus, Rain, Water pollution effects, Sediment-water interface, Stratification, Sulfur, Sulfur bacteria, Temperature, Urbanization.
Identifiers: *Linsley Pond (Conn), *Comparative studies, Cedar Lake (Conn), Clinolimnion, Deoxygenation, Hypereutrophication, Iron cycle, Manganese cycle, Sulfate reduction, Sulfur cycle, Thiopedia, X-ray emission spectroscopy.

Linsley Pond, Connecticut, has been studied for 30 years, while becoming increasingly hypereutrophic. From August 1965 through August 1966, author sampled water column of 14 meters weekly, monitored oxygen and temperature, and made a geochemical study of elements detectable by X-ray emission spectroscopy and their movement during thermal stratification. Process of heating, described during 1937-1938, has apparently changed. Late in 1966 heating period, a vertically undisturbed layer (5-7 meters) apparently transmitted heat downward solely by molecular conduction. Below this, heating was probably controlled by profilebound chemical density currents. Totals of calcium, magnesium, phosphorus and sulfur, though seasonally variable, are generally 2-8 times greater than in 1937-1938. Precipitation of ferrous sulfide tends to decrease sulfur in stagnated deeper waters. Iron concentrations of deep hypolimnion are markedly lower than 1938 values, while manganese, not precipitable as sulfide at usual pH, is strikingly higher. Phosphorus is now greatly enriched but is stoichiometrically less than Fe (II) in deep water, so that phosphorus sediments out as iron oxidizes during autumnal overturn. Cooper content is lower than recorded in 1937, increases in deeper hypolimnion being irregular and insignificant compared to iron and manganese. As in 1938, large seasonal changes in phosphorus were noted. (Eichhorn-Wisc)
W69-05869

THRESHOLD PREDICTION AND CHARACTERISTICS OF LOG-NORMAL PHENOMENA,
Northwestern Univ., Evanston, Ill. Dept. of Civil Engineering.
For primary bibliographic entry see Field 07C.
W69-05871

INTERACTION OF FOOD LEVEL AND EXPLOITATION IN EXPERIMENTAL FISH POPULATIONS,
Bureau of Commercial Fisheries, Seattle, Wash. Biological Lab.
Ralph P. Silliman.
Fish Bull, Vol 66, No 2, pp 425-439, 1968. 10 tab, 9 fig, 9 ref.

Descriptors: *Exploitation, *Fish populations, *Food abundance, Biomass, Growth.
Identifiers: *Interaction, *Yield, *Experimental populations, Lebistes reticulatus, Fishery dynamics, Population response, Management strategies.

Food supply and exploitation rate are important factors in determining biomass and yield of exploited fish populations. Nine experimental populations of guppies were exposed to combinations of food supply (0.5, 1.0, 1.5 times standard diet) and exploitation rate (0.25, 0.33, 0.50 per 3-week period) in 20-liter tanks over 72 weeks. The three-week period represents interval between broods. Food consisted of commercial dry fish food, frozen Daphnia and Artemia nauplii. Exploitation was in-

itiated at 29 to 34 weeks. Higher diet levels resulted in greater biomass over first 28 weeks, this due more to faster growth than better survival. Populations responded to exploitation by initial drop in biomass followed by stabilization at a lower level; numbers were less stable than weight. Yield-biomass and yield-exploitation rate comparisons indicate yield-exploitation rate relationship is independent of diet level. Maximum yields represented conversion efficiencies of 25% at all diet levels. Results suggest that management strategies may be applied independently of food abundance. Tabular data include weekly numbers, weights, food levels, and yields. Data in figures include growth and population size curves, yield-exploitation curves, and yield-biomass curves. (Voigtlander-Wisc)
W69-05873

ECONOMICS OF POLLUTION CONTROL,
Resources for the Future, Inc., Washington, D. C.
Allen V. Kneese.
For main entry see Field 06B, W69-05737. Water Resources and Econ. Develop. in the South, North Carolina Univ., API, Series 16, pp 97-107, Aug 1965. 11 p.

Descriptors: *Water pollution, *Water quality control, *Waste water treatment, Organic matter, Water pollution sources, Administrative agencies.
Identifiers: *Water pollution control in Germany.

A balance between the valuable use of water courses for waste disposal and the resultant external or downstream costs must be achieved. The usual economic institution of market forces in a private enterprise system does not result in a satisfactory balance between these costs and returns. Two federal devices of improving water quality are discussed. First is financial support to local communities to build water treatment facilities. The second device is federal subventions to local communities. Payments should be made for waste reduction rather than treatment. A possibility to control pollution is a charge on waste discharge reflecting the offsite costs associated with the discharge. Other possibilities of controlling are also discussed. The features of the success of the Rhur region water pollution control in Germany are given. (Grossman-Rutgers)
W69-05880

5D. Waste Treatment Processes

A FEASIBILITY STUDY OF A LIVESTOCK WASTE DISPOSAL SYSTEM INVOLVING THE REUSE OF WATER,
North Dakota State Univ., Fargo.
George L. Pratt.
Research Project Technical Completion Report to Office of Water Resources Research, December 1968, Washington, D. C. 24 p, 11 tab, 2 ref. OWRR Project A-001-NDAK.

Descriptors: *Water reuse, Stock water, Domestic animals, *Farm wastes, Potable water, Solid wastes, Urine, Water pollution, Aeration, Aerobic treatment, Biological treatment, Coagulation, Filtering systems, Filtration, Flocculation, Oxidation, Waste storages, *Waste water treatment, Water purification, Water treatment.

Separating solid materials from liquid wastes that have been removed from a livestock barn can be accomplished in several ways. In trials at the North Dakota Agricultural Experiment Station settling tanks and sand filters were evaluated. In one phase of the work treatment of overflow from a settling tank that collected beef waste was emphasized. No treatment, aeration, and treatment with aluminum sulfate (alum) were tested for the settling tank overflow. The settling tank removed the bulk of the solids. Alum treatment of the overflow was effective in reducing total solids to the point where it was nearly feasible to provide final treatment. In the second phase of the work a slow sand filter was tested under controlled conditions to determine its adaptability for final treatment of reclaimed water. Tests were run at three temperatures, 45 deg F, 70 deg F, and 100 deg F. Controlled amounts of organic material were added to the influent of the filter. The filter was easily managed and adaptable to a wide range of conditions. Its performance was better at 70 deg F than at 45 deg F or 100 deg F.
W69-05753

CONCENTRATION AND ACCUMULATION OF METALLIC IONS BY THE BACTERIUM ZOOGLOEA,
Ohio State Univ., Columbus.
Barry A. Friedman, and Patrick R. Dugan.
Develop. Industrial Microbiol. Vol 9, pp 381-388, 1968. 8 p, 4 fig, 1 tab, 10 ref.

Descriptors: *Zoogloea bacteria, *Flocs, Metal accumulation, Ion concentration, Pollution treatment, *Water treatment, Chemical removal.
Identifiers: Bacteria Zoogloea, Pollution abatement, Cation absorption, Water purification.

Zoogloea ramigera flocs concentrate high concentrations of Zn++, Co++, Cu++, Ni++ and Fe+++ from aqueous solution. The metal ions are adsorbed and bound to the gelatinous matrix material that surrounds the bacterial cells. These aquatic bacteria are indigenous to aerobic treatment systems and appear to remove metals from natural and contaminated water and have potential in tertiary water treatment.
W69-05767

NUTRIENT REMOVAL FROM SECONDARY EFFLUENT BY ALUM FLOCCULATION AND LIME PRECIPITATION,
Wisconsin Univ., Madison. Dept. of Civil Engineering.
S. K. Malhotra, G. Fred Lee, and G. A. Rohlich.
Int J Air Wat Poll, Vol 8, pp 487-500, 1964. 11 fig, 1 tab, 12 ref.

Descriptors: *Eutrophication, *Phosphorus compounds, *Nitrogen compounds, Alkylbenzene sulfonate, Ammonia, Chemical oxygen demand, Estimated costs, Flocculation, Nitrates, Nitrites, Sewage treatment, Tertiary treatment, Water chemistry, Water pollution control.
Identifiers: *Lime precipitation, *Alum flocculation, *Nutrient removal, *Secondary effluents, Alkalization, Alum, Jar tests, Precipitation treatment.

Conditions were studied for removal of phosphorus and nitrogen compounds from biochemically treated wastewater effluents by alum flocculation and lime precipitation. They flocculated or precipitated samples of secondary effluent according to conventional Jar Test procedures. Phosphorus removal was highly pH dependent with an optimum pH of 5.57 plus-or-minus 0.25. At this pH, an alum dose of 250 milligrams/liter removed 95% of total phosphorus, 55% of the chemical oxygen demand, 60% of the organic nitrogen, 25% of the nitrate-nitrogen and nitrite-nitrogen, 17% of the apparent alkylbenzene sulfonate, and none of the ammonia-nitrogen. A dose of 600 milligrams/liter of calcium hydroxide raised pH sample to 11 and removed 99% of total phosphorus. Estimated chemical costs for removal of 95% of total phosphorus by lime and alum were 32 and 73 dollars per million gallons, respectively. (Rohlich-Wis)
W69-05865

USE POLLUTION TO BENEFIT MANKIND,
Vitro/Hanford Engineering Services, Richland, Wash.
J. Leon Potter.
Ocean Ind, Vol 4, No 5, pp 94-97, May 1969. 4 p, 1 fig, 2 tab, 4 ref.

Descriptors: *Waste treatment, *Aquiculture, Algae, Yeasts, Bacteria, Fish, Proteins, Oil wastes, Oily water, Sulfite liquors, Ultimate disposal, Water reuse, Fish farming.
Identifiers: *Oil spills, Protein aquiculture.

Organic waste, heated water, sewage nutrients, oil wastes, and garbage may be used as nutrients for growing algae, bacteria, and yeasts to produce proteins. Waste low-grade petroleum is used in a plant at Lauera, France. A pound of bacteria, feeding on crude so worthless it is usually burned, can produce 10 lbs of protein a day. Waste effluents rich in carbohydrates, sugars and inorganic nutrients may be collected and separated into solids and liquids. The solids are good fertilizers and animal feed additives, while the soluble nutrients may be used by Torula yeast for protein production. Heated water discharges may be used to increase the production of fish. The cost of protein produced from wastes is about 3 cents per lb, compared with farm-grown protein prices of about 10 cents. Analyses of Torula yeast and algae are tabulated. (Knapp-USGS)
W69-05891

QUALITY STANDARDS FOR NATURAL WATERS,
For primary bibliographic entry see Field 05G.
W69-05934

5E. Ultimate Disposal of Wastes

USE POLLUTION TO BENEFIT MANKIND,
Vitro/Hanford Engineering Services, Richland, Wash.
For primary bibliographic entry see Field 05D.
W69-05891

HYDROGEOLOGIC DATA FROM FOUR LANDFILLS IN NORTHEASTERN ILLINOIS,
Illinois State Geological Survey, Urbana.
For primary bibliographic entry see Field 07C.
W69-05896

5F. Water Treatment and Quality Alteration

FACTORS INFLUENCING THE EFFECTIVENESS OF SWIMMING POOL BACTERICIDES,
Wisconsin Univ., Madison. Water Chemistry Lab.
G. P. Fitzgerald, and M. E. DerVartanian.
Appl Microbiol, Vol 15, No 3, pp 504-509, May 1967. 5 fig, disc, 13 ref.

Descriptors: *Water purification, *Water quality control, *Swimming pools, *Bactericides, Water chemistry, Water treatment, Streptococcus, Chlorine, Ammonia.
Identifiers: *Streptococcus faecalis, *Chlorine stabilization, *Cyanuric acid.

Techniques for culturing, harvesting, and testing bacteria to evaluate bactericidal chemicals for swimming pools are described. Concentrations of 25, 50, and 100 mg of the chlorine stabilizer cyanuric acid per liter increased the time required for a 99% kill of Streptococcus faecalis by 0.5 mg of chlorine per liter at pH 7.4 and 20 deg C from less than 0.25 min without cyanuric acid to 4, 6, and 12 min, respectively. The effect of concentrations of ammonia nitrogen in the range found in swimming pools on the rate of kill of 0.5 mg of chlorine per liter and of chlorine plus cyanuric acid was tested. At concentrations of ammonia nitrogen greater than 0.05 mg per liter, faster rates of kill of S faecalis were obtained with 100 mg of cyanuric acid per liter plus 0.5 mg of chlorine per liter than with 0.5 mg of chlorine per liter alone. When water samples from four swimming pools with low ammonia levels were used as test media, 0.5 mg of added chlorine per liter killed 99.9% of the added S faecalis in less than 2 min, but water from a pool with a large number of children required 60 to 180 min of treatment. (Fitzgerald-Wis.)
W69-05694

USE OF POTASSIUM PERMANGANATE FOR CONTROL OF PROBLEM ALGAE,
Wisconsin Univ., Madison. Hydraulic and Sanitary Lab.
George P. Fitzgerald.
J Amer Water Works Assoc, Vol 58, No 5, pp 609-614, 1966. 1 fig, 1 tab, 20 ref.

Descriptors: *Nuisance algae, *Algicides, *Copper sulfate, *Water quality control, Algal control, Slime, Taste-producing algae, Odor-producing algae, Diatoms, Cyanophyta, Chlorophyta, Iron, Manganese, Eutrophication, Water pollution control.
Identifiers: *Potassium permanganate, Algicidal tests, Algistatic tests, Slimeproducing algae, Photomicrographs, Microcystis aeruginosa, Anabaena circinalis, Gloeotrichia echinulate, Oscillatoria rubescens, Oscillatoria chalybia, Hydrodictyon reticulatum, Dictyosphaerium pulchellum, Gomphonema, Dinobryon.

Author treated following species of algae with various concentrations of potassium permanganate and copper sulfate to determine concentrations required to kill cells after 12 and 72 hours' treatment and to prevent growth: (bloomforming cyanophytes) Microcystis aeruginosa, Anabaena circinalis, Gloeotrichia echinulata, Oscillatoria rubescens; (filter-clogging cyanophyte) Oscillatoria chalybia; (filter-clogging chlorophytes) Hydrodictyon reticulatum, Dictyosphaerium pulchellum; (diatom) probably Gomphonema. Toxicity of copper sulfate was highly variable; cyanophytes except Oscillatoria were killed at concentrations of 0.1 ppm; O rubescens was killed after 4 hours at 0.4 ppm; growth of O chalybia and Hydrodictyon was inhibited by 0.1-0.2 ppm but algicide required 0.6-0.8 ppm for 72 hours; inhibition of Dictyosphaerium and the diatom required 0.4 ppm, while algicide required more than 8 ppm and 72 hours. With potassium permanganate, all species except Dictyosphaerium were killed by 1-5 ppm. Author speculates that variations in effectiveness of copper may result from variations in metabolic rates, metabolic processes, or rates of absorption among the several species. He suggests that potassium permanganate treatment of raw-water reservoirs may be multiply effective for algicide for elimination of tastes and odors resulting from decomposed algae and other sources and for removal of iron and manganese. (Eichhorn-Wis)
W69-05704

5G. Water Quality Control

IMPOUNDMENT AND TEMPERATURE EFFECT ON WASTE ASSIMILATION,
Vanderbilt Univ., Nashville, Tenn. Dept. of Sanitary and Water Resources Engineering.
For primary bibliographic entry see Field 05C.
W69-05637

REAERATION PREDICTION IN NATURAL STREAMS,
Vanderbilt Univ., Nashville, Tenn. Dept. of Sanitary and Water Resources Engineering.
For primary bibliographic entry see Field 05C.
W69-05638

RECOMMENDATIONS FOR WATER POLLUTION CONTROL IN RACCOON CREEK BASIN, OHIO.
Federal Water Pollution Control Administration, Washington, D. C.

Fed Water Pollut Contr Admin, Ohio Basin Reg Rep, Nov 1967. 81 p, 20 fig, 18 tab, 13 ref, 4 append.

Descriptors: *Water pollution sources, *Acid mine water, *Ohio, Mining, Acidic water, Mine acids, Mine drainage, Iron, Sulfates, Water pollution control, Non-structural alternatives, Pollution abatement, Reservoirs, Recreation.
Identifiers: Raccoon Creek Basin (Ohio).

Pollution of the Raccoon Creek basin, Ohio, by acid mine drainage was investigated and recommendations for pollution abatement are presented. The hilly, forested, sparsely-populated basin and surrounding area are considered by the State of Ohio as an ideal location for public recreation development. The outstanding hindrance to development is the degraded water quality and unsightly condition of many of the area streams caused by coal mine drainage. Aquatic life and fish production are acutely restricted, recreation is curtailed, economic growth is stifled, and aesthetic values are adversely affected. Seven subwatershed areas are the principal sources of acid mine drainage. A minimum reduction of 60% in net acid load through physical abatement efforts in the 7 watersheds would approximate alkaline conditions in the lower portion of Raccoon Creek. Pollution from inadequately treated sewage occurs in Indian Creek below Rio Grande, Ohio. Oil and brine wastes from several low production oil wells located in the northwestern corner of the basin enter the Raccoon drainage. Suspended sediments occur in harmful concentrations only periodically, usually during or immediately following periods of intense and prolonged rainfall. The Ohio Department of Natural Resources is studying the feasibility of a 1,000-acre, 20-mi long impoundment on lower Raccoon Creek for flood control, water supply, recreation, and pollution control. Because of the acid condition of the water to be impounded, recreational benefits would be exclusive of sport fishing activity. (Knapp-USGA)
W69-05661

LIST OF REFERENCES ON CONTROL OF AQUATIC PLANTS, INCLUDING ALGAE,
Chipman Chemical Co., Inc., Bound Brook, N. J. Research Div.
Margaret Greenwald.
(Internal Publication), Chipman Chemical Co, Inc, Bound Brook, NJ, Jan 1956. 22 p, 716 ref.

Descriptors: *Bibliographies, *Algal control, *Aquatic weed control, *Eutrophication, Aquatic plants, Herbicides, Pesticides, Harvesting, Water quality control, Water pollution control, Water pollution effects.
Identifiers: Biocides.

Although this bibliography comprises some 716 entries, in its preface the compiler states that it is neither complete nor selected. However, emphasis was placed on recent works. 263 of the dated works were published between 1950 and 1966. Earliest citation is dated 1896, and the list is almost exclusively from the literature in English. In most cases, biological and ecological studies were omitted, but some handbooks, general texts, and a few miscellaneous references are included where they have been useful in plant identification or the understanding of conditions associated with plant control or give information on problems related to plant control (e.g., toxicity of herbicides to animal organisms). (Eichhorn-Wis)
W69-05705

SUPPLEMENT TO THE LIST OF REFERENCES ON CONTROL OF AQUATIC PLANTS, INCLUDING ALGAE,
Chipman Chemical Co., Inc., Bound Brook, N. J. Research Div.
Margaret Greenwald.
(Internal Publication), Chipman Chemical Co, Inc, Bound Brook, N. J., Jan 1957. 12 p, 258 ref.

Descriptors: *Bibliographies, *Algal control, *Aquatic weed control, *Eutrophication, Aquatic plants, Herbicides, Pesticides, Harvesting, Water quality control, Water pollution control, Water pollution effects, Fungi, Aquatic Fungi.
Identifiers: Biocides.

This supplement records corrections to compiler's original bibliography, and adds 258 entries to the original 716. Original coverage of aquatic plants and algae is extended to include a few references to aquatic fungi. New citations are for literature published between 1922 and 1957, 134 having been published during the period 1950-1957. (Eichhorn-Wis)
W69-05706

THE RANGE OF CHOICE IN WATER MANAGEMENT. A STUDY OF DISSOLVED OXYGEN IN THE POTOMAC ESTUARY,
Resources For the Future, Washington, D.C.
R. K. Davis.
Baltimore, The Johns Hopkins Press, 1968. 196 p, 22 fig, 28 tab, 100 ref, 4 append.

Descriptors: *Water management (Applied), *Administrative decisions, *Water resources, Planning, Political constraints, Institutional constraints, Water quality control, River basin development, Political aspects, Mathematical models, Decision making.
Identifiers: Potomac River.

The technical and institutional components of water resource planning were analyzed. Four major questions were considered: (1) the number of courses of action technically open to solution of water quality management problems; (2) the analytical problems involved in each alternative; (3) the institutional and procedural obstacles limiting alternatives offered to planners; and (4) the responsibilities of political leaders. The Potomac River Basin report of the Corps of Engineers was examined, with special attention given to the alternative plans suggested for maintaining dissolved oxygen in the estuary. It was concluded that several alternatives for setting and achieving standards were not considered in detail. A model which showed how the Potomac might have been studied was provided. Some of the implications of the study for water resources planning in general were assessed. (Gysi-Cornell)
W69-05715

WATER QUALITY MODELS OF THE ESTUARY,
Federal Water Pollution Control Administration, Washington, D. C.
Leo J. Hetling.
Appendix A, The Range of Choice in Water Management: A Study of Dissolved Oxygen in the Potomac Estuary, The Johns Hopkins Press, pp 141-149, 1968. 9 p, 3 fig, 1 tab.

Descriptors: *Water quality, *Mathematical models, Dissolved oxygen, Water management (Applied), Oxygen sag, Optimization, Sewage treatment, Planning, *Estuaries, River systems.
Identifiers: Potomac Estuary.

Three water quality models of the Potomac Estuary which evolved in recent planning models were reviewed. The models described the causal connections between dissolved oxygen concentrations in the estuary and the natural and man-made forces which affected them. The models were then used to forecast the consequences of management activities at sewage treatment plants in the estuary. The results usually indicated optimum treatment levels to be used. Two of the models reviewed used empirical relationships based on observations in the estuary. The third used the theoretical relationship of the 'oxygen-sag' equation. A comparison of results from the three studies was graphed and briefly discussed. (Gysi-Cornell)
W69-05716

RESERVOIR SYSTEM SIMULATION,
Resources for the Future, Inc., Washington, D. C.
Robert M. Steinberg.
Appendix C, The Range of Choice in Water Management: A Study of Dissolved Oxygen in the Potomac Estuary, The Johns Hopkins Press, pp 161-177, 1968. 17 p, 7 fig.

Descriptors: *Simulation analysis, *River systems, Reservoir design, *Reservoir operation, *Planning, Water management (Applied), River regulation,

Computer models, Consumptive use, Hydrologic data, Estuaries, Water quality control, Standards, Dissolved oxygen, Probability.
Identifiers: Potomac Estuary.

A river basin simulation for the Potomac Estuary was described. The basic components of the simulation were: (1) Reservoirs: (a) size, (b) release rules, (c) consumptive losses; (2) Control Points; (a) target flows, (b) consumptive losses; (3) Hydrologic inputs; and (4) a DO model of the estuary. The objectives of the analysis were: (1) to study the performance of any reservoir system with respect to any DO quality standard in the estuary; (2) to check a trial-and-error method of scaling the system to meet certain target outputs; and (3) to describe the performance of the reservoir system in terms of probability of failure at a given level of performance. The methodology of the simulation was described and shown schematically. Typical output results were tabled and discussed. (Gysi-Cornell)
W69-05717

WATER QUALITY MANAGEMENT AND SOME POLICY MODELS,
Georgia Inst. of Tech., Atlanta; Clemson Univ., S. C.
William W. Hines, and Benjamin C. Dysart.
Pap, 1968 Region IV Conf, Amer Inst Ind Eng, Nov 8, 1968. 30 p, 3 fig, 25 ref.

Descriptors: *Dynamic programming, *Water quality control, *Water management (Applied), *River systems, Thermal pollution, Dissolved oxygen, Biochemical oxygen demand, Standards, Political constraints, Stream improvement, Wastewater treatment, Water cooling.

A dynamic programming water quality management model was presented. The objective was to determine the level of waste treatment and cooling required at sources of pollution along a river in order to minimize total regional treatment cost, subject to dissolved oxygen and temperature standards. Cost functions for treatment were assumed known. Transfer functions for temperature, BOD, and dissolved oxygen were based on exponential decay equations and the Streeter-Phelps equation respectively. The deoxygenation and reaeration coefficients of the Streeter-Phelps equation were assumed to be functions of stream temperature. It was concluded that the model could provide for more economic efficiency in regional water quality management if organizational cost sharing plans became politically acceptable. (Gysi-Cornell)
W69-05722

COLLECTIVE FACILITIES IN WATER QUALITY MANAGEMENT,
Ohio State Univ., Columbus; and Resources for the Future, Inc., Washington, D. C.
J. Hayden Boyd.
For main entry see Vol 2, No 11, W69-04578.
Managing Water Quality: Economics, Technology, Institutions, pp 199-212, by Kneese and Bower, The Johns Hopkins Press, 1968. 14 p.

Descriptors: *Economics, *River basins, *Water quality, *Water management (Applied), Water policy, Waste assimilative capacity, Waste water treatment, River basin commissions, Water resources development, Optimization, Water allocation (Policy).

An economic maximization model was presented which treated the river basin as a multiple-product natural asset. The products were of two types, waste removal services or water quality services. It was assumed that the river basin asset was controlled by an authority wishing to invest a Pareto-optimal level of resources in river-basin capacity, and, given that capacity at any moment in time, to allocate the services in a Pareto-optimal fashion, amongst the firms in the basin. The model was solved by the method of La Grangian multipliers to find the optimal levels of inputs, discharges, investment in waste assimilative capacity and effluent charges, for the basin. (Gysi-Cornell)
W69-05726

DISSOLVED OXYGEN IN THE DELAWARE ESTUARY,
Resources for the Future, Inc., Washington, D. C.
Allen V. Kneese, and Blair T. Bower.
For main entry see Vol 2, No 11, W69-04578.
Managing Water Quality: Economics, Technology, Institutions, pp 158-164, The Johns Hopkins Press, 1968. 7 p, 1 fig, 1 tab.

Descriptors: *Computer models, *Linear programming, *Water quality control, *Waste water treatment, Economic efficiency, Dissolved oxygen, Standards, Estuaries, *Water policy, Stream improvement, River systems, Administrative decisions, Political constraints, Delaware River.
Identifiers: *Effluent charges.

A study of effluent charges as a means of achieving a water quality standard in the Delaware Estuary was described. The basic tool of the study was a computer model used for forecasting dissolved oxygen conditions in the estuary. A linear programming cost opitmization model was superimposed on the physical model to check the effects of various treatment policies for the estuary. The following policies were compared: (1) Least Cost (LC); (2) Uniform Treatment (UT) throughout the estuary; (3) Single Effluent Charge (SECH) throughout the estuary; and (4) Zoned Effluent Charge (ZECH), or single charges within zones. Summarized results of the study were tabled. It was concluded that the effluent charge method was administratively feasible, and that it approached the (LC) method in economic efficiency. (Gysi-Cornell)
W69-05727

THE DELAWARE ESTUARY STUDY,
Resources for the Future, Inc., Washington, D. C.
Allen V. Kneese, and Blair T. Bower.
Managing Water Quality: Economics, Technology, Institutions, pp 224-235, The Johns Hopkins Press, 1968. 12 p, 1 fig, 4 tab.

Descriptors: *Linear programming, *Water quality control, *Water policy, Waste water treatment, *Administrative decisions, Dissolved oxygen, Standards, *Alternative costs, Public benefits, Computer models, Stream improvement, Estuaries, Delaware River.

A linear programming economic optimization model was combined with a physical (oxygen sag) model of the Delaware Estuary to permit comparison of alternative modes of water quality control with the least-cost solution. Five 'objective sets' were investigated, ranging from maintenance of 1964 quality conditions, up to considerable improvement in quality resulting in increased water contact recreation. The summarized results of the study, for uniform treatment, zoned treatment and least-cost treatment were tabled and discussed. Benefits which would result from the various objective levels were described and tabled. Other methods for stream improvement, such as regional collection, ocean disposal and mechanical reoxygenation were briefly discussed. (Gysi-Cornell)
W69-05728

MATHEMATICAL SIMULATION OF THE ESTUARINE BEHAVIOR AND ITS APPLICATIONS,
General Electric Co., Philadelphia, Pa; and Federal Water Pollution Control Administration, Philadelphia, Pa.
John M. Jeglic, and George D. Pence, Jr.
Pap, Annu Symp Appl Computers Problems Urban Soc, New York, N Y, Nov 1967. 63 p, 19 fig, 8 ref.

Descriptors: *Simulation analysis, *Water pollution control, Estuaries, River systems, Biochemical oxygen demand, Dissolved oxygen, Mathematical models, Digital computers, Analytical techniques, *Approximation method, Numerical analysis, Stream improvement, Delaware River.

A mathematical model was developed to simulate the response of dissolved oxygen to various inputs in a river system. The model was applied to a study of the Delaware Estuary. The objective was to forecast the results of proposed water pollution control schemes and to estimate their chances for success. A numerical approximation method was used to solve the differential equations for BOD and DO. The method used a special integration step size control procedure developed to optimize use of digital computer time. The application of the model to the Delaware study was described and results were graphed and discussed. (Gysi-Cornell)
W69-05732

CHICAGOLAND DEEP TUNNEL SYSTEM FOR POLLUTION AND FLOOD CONTROL: FIRST CONSTRUCTION ZONE, DEFINITE PROJECT REPORT.
Harza Engineering Co., Chicago, Ill.; and Bauer Engineering, Inc., Chicago, Ill.

Work performed for Metropolitan Sanitary District of Greater Chicago. Harza Engineering Co and Bauer Engineering, Inc, Chicago, Ill, May 1968, 199 pp, 10 map, 15 dwg, 26 tab, 14 chart.

Descriptors: *Multiple-purpose projects, *Pollution abatement, *Flood control, Project purposes, Overflow, Pumped storage, Generators, Operations, Sewerage, Water quality, Reservoir operation, Water treatment, Costs, Financing.
Identifiers: *Deep tunnel system, *Calumet Area (Illinois), *Chicago (Illinois).

The deep tunnel system is a multipurpose project to capture polluted storm overflows, treat them, and gradually return them to the waterways. The system, when not in use, pumps water to generate power. Chapter One briefly describes the program for the entire Chicago area. Selection of the Calumet area as the first construction zone is justified. The investigations program for the zone is described. Chapter Two gives the general concept of the plan, summarily describes project features, and discusses operation of the entire system. Chapter Three discusses existing waterflows. It examines the service area, waterways, the existing combined sewer system, flooding problems, hydrological aspects of combined sewer overflows, and quality of overflows. Chapter Four through Eight discusses project features at length; chapter Four covering the interception and conveyance structures, five, the mined storage reservoir; six, the pumping-generating station; seven, the surface reservoir and regulating facilities; and, eight, water treatment facilities and processes. Chapter Nine discusses overall system operation. Chapter Ten defines alternatives and provisions for expansion. Chapter Eleven outlines project implementation and cost estimates. The last two chapters summarize and justify the project, and discuss its financing. (Gossen-Chicago)
W69-05743

WATER QUALITY CONTROL: COMPREHENSIVE PLANNING,
James L. Agee.
Oregon State University, Seminar Proceedings: Water Quality Control, January 1965, pp 101-111. 11 p.

Descriptors: *Water pollution control, Programs, Water supply, Water utilization, Waste water (Pollution), Basins, Inter-agency cooperation, Benefits, Projects.
Identifiers: *Comprehensive planning, *Water Pollution Control Act.

Agee defines 'comprehensive' planning as all-inclusive planning. As such, it considers physical entities, such as land and water resources in an entire region or basin, and social patterns, political struc-

ture, economic background, and activities which characterize the area. Agee explains the need for comprehensive water management planning. He lists planning policies formulated by Congress in passing the Federal Water Pollution Control Act. Comprehensive water pollution control programs required by this Act involve six considerations: (1) amount of water available and its pattern of occurrence; (2) existing water uses and waste water discharges in the basin; (3) physical, chemical, and biological characteristics of basin waters; (4) existing and projected future population and industrial developments; (5) geographic and natural resource characteristics of the basin that affect or relate to water quality; and, (6) amounts, locations, and characteristics of the future waste water discharges to the stream. Agee explains how to prepare the final water quality control plan. The organization and cooperation of agencies necessary to undertake comprehensive program studies are outlined and the benefits of such studies are evaluated. Defined are criteria for selection of projects, and places where comprehensive water pollution control studies have been started. (Gossen-Chicago)
W69-05744

WATER QUALITY CONTROL: LEGAL AND ADMINISTRATIVE ASPECTS,
Curtiss M. Everts.
Oregon State University, Seminar Proceedings: Water Quality Control, January 1965, pp 112-120. 9 p.

Descriptors: *Legal aspects, *Administration, *Water pollution control, Water law, Oregon, Federal government, State governments, Research facilities, Planning, Training.

Everts divides laws governing water pollution control programs into two categories: basic statutes and laws designed for the special protection of specific waters or water users. He defines the first category and exemplifies the second with Oregon laws. Many of these laws have outlived their usefulness and inadequately protect water quality. Everts recommends periodical review of all state laws. He describes four early federal pollution laws: The Rivers and Harbors Act of 1899, the Public Health Service Act of 1912, the Oil Pollution Act of 1924, and the Federal Water Pollution Control Act of 1948. Provisions of the Federal Water Pollution Control Act of 1956 and its amendments in 1961 are listed. State and federal laws are compared and the responsibilities of each government are discussed. Once the laws are in effect, administering agencies must create programs. Seven requisites for production of effective programs are: (1) a highly qualified technical staff; (2) adequate facilities for research and planning; (3) collection and collation of data; (4) development of a comprehensive plan based on the data; (5) an aggressive public information program; (6) initiation of research; and (7) initiation of enforcement action when voluntary cooperation fails. Selection and training of staff, and development of public support are discussed. (Gossen-Chicago)
W69-05745

A STUDY OF GROUNDWATER CONTAMINATION DUE TO SALINE WATER DISPOSAL IN THE MORROW COUNTY OIL FIELDS,
Ohio State Univ., Columbus. Dept. of Geology.
For primary bibliographic entry see Field 05B.
W69-05749

A FEASIBILITY STUDY OF A LIVESTOCK WASTE DISPOSAL SYSTEM INVOLVING THE REUSE OF WATER,
North Dakota State Univ., Fargo.
For primary bibliographic entry see Field 05D.
W69-05753

CREATION OF WATER AND SEWAGE DISPOSAL AGENCIES.
For primary bibliographic entry see Field 06E.
W69-05788

OPERATIONAL HYDROLOGY USING RESIDUALS,
Federal Water Pollution Control Administration, Washington, D. C.
For primary bibliographic entry see Field 06A.
W69-05847

ANALOG COMPUTER -- A MODERN TOOL IN WATER POLLUTION CONTROL,
Du Pont de Nemours (E. I.) and Co., Wilmington, Del.
Lloyd L. Falk.
Proc, Amer Soc Civil Eng, Vol 88, No SA6, pp 31-59, Nov 1962. 20 p, 19 fig, 3 tab, 20 ref, 1 append.

Descriptors: *Analog computers, *Water pollution control, *Mathematical model, Streamflow, Computer programs, Oxygen sag, Biochemical oxygen demand, Thermal pollution, Dynamics, Kinetics.
Identifiers: Differential equations.

The applicability of digital and analog computers to the solution of water pollution mathematical model were compared. The suitability of the analog computer for the solution of differential equations and problems in kinetics not presently solvable by known mathematical techniques was described. Demonstration problems including first-order differential single and two-stage biochemical oxygen demand equations, the oxygen sag equation and the second order equation describing pollutant distribution in a tidal estuary were solved. A computer program was given for a variable cross section stream with multiple sources of organic pollution and heat loads, with continuously varying oxygen saturation values, deoxygenation and reaeration coefficients, and with continuously varying temperature corrections to those coefficients. (Gysi-Cornell)
W69-05854

DIGITAL COMPUTERS AND ENVIRONMENTAL CONTROL,
Cornell Univ., Ithaca, N. Y.
Gordon P. Fisher, and Walter R. Lynn.
Proc, Amer Soc Civil Eng, Vol 90, No PP1, pp 15-20, Jan 1964. 6 p.

Descriptors: *Digital computers, *Environmental engineering, Analytical techniques, Engineering education, Future planning (Projected).

Concepts of environment were presented and the limitations on the achievement of environmental control imposed by classical methods were examined. The particular aspects of environmental engineering and control were: (1) the role of the digital computer in manipulation of the environment; (2) the related techniques that have helped improve the generality and credibility of solutions to environmental problems; (3) the educational responses that engineers have made in order to use those techniques effectively; and (4) the promise held by those improved and powerful techniques. (Gysi-Cornell)
W69-05855

SIGNIFICANCE OF REDOX POTENTIAL IN NATURAL WATERS (IN FRENCH),
Paris Univ., St. Maur (France). Faculte des Sciences.
For primary bibliographic entry see Field 02K.
W69-05877

ECONOMICS OF POLLUTION CONTROL,
Resources for the Future, Inc., Washington, D. C.
For primary bibliographic entry see Field 05C.
W69-05880

WATER QUALITY IN HAWAII,
Hawaii Univ., Honolulu. School of Public Health.
Nathan C. Burbank.
J Amer Water Works Ass, Vol 61, No 4, pp 166-169, Apr 1969. 4 p, 3 photo.

Descriptors: *Water quality, *Standards, *Hawaii, Groundwater, Surface waters, Municipal water, Irrigation, Public health, Recreation, Tourism, Water quality control, Water pollution sources.
Identifiers: Sugar industry wastes.

Water quality in Hawaii is generally excellent, and extremely restrictive standards were set to maintain or improve it. Most of the State's public water sources are lenses of fresh groundwater above salt water in highly permeable volcanic rocks. Recharge areas are protected by prohibiting access and maintaining good surface conditions. The main pollution hazard of the State is its sugar industry, which not only adds nutrients and insecticide residues to groundwater, but also adds turbidity and vegetable waste to surface discharges. These practices are now carefully regulated. Municipal waste discharge quality is carefully controlled to maintain the esthetic quality necessary in a State that depends on its beauty for its major source of income, tourism. (Knapp-USGS)
W69-05893

MICROBIAL SULFATE REDUCTION AND ITS POTENTIAL UTILITY AS AN ACID MINE WATER POLLUTION ABATEMENT PROCEDURE,
Ohio State Univ., Columbus. Dept. of Microbial and Cellular Biology.
Jon H. Tuttle, Patrick R. Dugan, and Chester I. Randles.
Appl Microbiol, Vol 17, No 2, pp 297-302, Feb 1969. 6 p, 3 fig, 4 tab, 8 ref. OWRR Grant No 14-01-0001-805-980.

Descriptors: *Water pollution control, *Biodegradation, *Sulfates, *Acid mine water, Reduction (Chemical), Bacteria, Hydrogen ion concentration, Oxidation-reduction potential, Nutrients, Fermentation.
Identifiers: *Sulfate reducing bacteria.

The presence of high concentrations of sulfate, iron, and hydrogen ions in drainage from coal mines and other areas containing waste pyritic materials is a serious water pollution problem. Sulfate can be removed from solution by microbial reduction to sulfide and subsequent precipitation as FeS. A mixed culture of microorganisms degraded wood dust cellulose, and the degradation products served as carbon and energy sources for sulfate-reducing bacteria. Metabolism of carbon compounds resulted in a net pH increase in the system. Oxidation-reduction potential (Eh) and temperature and carbon supplements were studied in an effort to accelerate the sulfate reduction process, with the ultimate objective of utilizing the process as a pollution abatement procedure. (Knapp-USGS)
W69-05898

MICROBIAL DISSIMILATORY SULFUR CYCLE IN ACID MINE WATER,
Ohio State Univ., Columbus. Dept. of Microbial and Cellular Biology.
For primary bibliographic entry see Field 05B.
W69-05899

QUALITY STANDARDS FOR NATURAL WATERS,
John J. Gannon.
Proc Nat Symp on Quality Stand for Natur Waters, July 1966, Mich Univ, 1967. 315 p.

Descriptors: *Water pollution control, *Water quality act, *Water quality control, *Standards, Water pollution effects, Water pollution sources, Water pollution treatment, Legislation, Governments, Waste treatment.
Identifiers: Water quality standards.

Quality standards for natural waters were discussed in a conference at University of Michigan, July 1966 to explore in a university setting, the issues involved in the establishment of standards on in-

terstate waters as required in the Water Quality Act of 1965. The symposium program was designed to be of interest to water pollution scientists, administrators, members of water pollution control boards, economists, and attorneys. The general topics discussed were developments in water quality control, meaning of water quality standards, streamflow regulation, water and wastewater treatment, quality requirements for specific uses, natural purification, water quality characterization, and management of pollution sources. A total of 35 papers were presented. (Knapp-USGS)
W69-05934

A FRAMEWORK FOR THE MULTIPLE USE OF MUNICIPAL WATER SUPPLY AREAS,
Cornell Univ., Ithaca, N. Y.
For primary bibliographic entry see Field 06D.
W69-05935

CITY OF MERIDIAN V TINGLE (RECOVERY OF DAMAGES AGAINST MUNICIPALITY FOR CREEK POLLUTION).

84 So 2d 388-391 (Miss 1956).

Descriptors: *Mississippi, *Water pollution, *Municipal wastes, Sewage effluents, Water pollution sources, Water pollution effects, Sewage, Damages, Path of pollutants, Legal aspects, Judicial decisions, Cities, Odor, Waste water (Pollution), Water quality, Public health, Property values, Remedies, Natural streams, Prescriptive rights, Riparian rights, Relative rights.
Identifiers: Nuisance (Public).

Plaintiff sued defendant municipality to recover special damages allegedly resulting from defendant's discharging sewage into creeks which ran through plaintiff's land. Plaintiff claimed damages for the loss of use and market value of his land. He also requested compensation for personal inconvenience and possible injury to the health of himself and his family brought about by foul odors and unhealthful conditions created by the maintenance of this public nuisance. The city admitted discharging the sewage, but claimed a prescriptive right to do so. The appellate court affirmed the jury verdict in favor of plaintiff. The court held that evidence supported the verdict that the method and manner used by the city constituted a public nuisance, and the city could not acquire by prescription the right to maintain such nuisance. The court ruled that it was not reversible error to allow the jury to decide whether the city had any prescriptive right, nor was it error to refuse to allow introduction into evidence of a water sample taken after the period of the suit. (Wheeler-Fla)
W69-05955

BEALS V ROBERTSON (MINE WATER RUNOFF).

159 Pa Super 325, 48 A 2d 56-57 (1946).

Descriptors: *Pennsylvania, *Riddance (Legal aspects), *Mine water, *Surface runoff, Drainage water, Repulsion (Legal aspects), Surface water, Reasonable use, Natural streams, Artificial watercourses, Watercourses (Legal), Mine drainage, Coal mines, Water pollution sources, Natural use, Water pollution, Flow augmentation, Legal aspects, Judicial decisions.
Identifiers: Upper landowners, Lower landowners.

Plaintiff seeks to enjoin defendant from the discharging of mine waters into a natural watercourse which flows from defendant's land uninterrupted across intervening land onto plaintiff's property. The court, denying the injunction, held that owners of upper land may have water flowing from their land discharged into a natural watercourse upon lower land. Upper landowners may not make new channels nor increase the flow by artificial means, but they may increase the flow by a natural and reasonable use of their land. (Helwig-Fla)
W69-05956

STATE V AMERICAN ALKYD INDUSTRIES (PENAL LIABILITY FOR WATER POLLUTION STRICTLY CONSTRUED).

32 N J Super 150, 107 A 2d 830-832 (1954).

Descriptors: *Water pollution, *Fishkill, *New Jersey, *Tidal waters, Judicial decisions, Water pollution effects, Water pollution sources, Fuels, Oily water, Pollutants, Legislation.
Identifiers: Penalties (Criminal).

Defendant was charged under a penal statute for allowing fuel oil to run into fresh or tidal waters, thereby causing destruction of wild life. The pollution occurred when the defendant's employee negligently permitted a 1,000 gallon receiving tank to overflow while he was absent from his duties in violation of the defendant's instructions. This court reversed a judgment of conviction. Where a law is both remedial and penal, those provisions which are remedial are to be liberally construed and those which are penal are to be strictly construed. The decision turned on construction of the word 'allow' as used in the statute, the court reasoning that a judgment of conviction must be supported by a finding that the defendant had actual or implied knowledge of, and acquiesced in or tolerated, the pollution. The defendant could not be said to have 'allowed' the pollution since he did not take any active part in it and did not acquiesce in, or approve the negligent and disobedient act to his employee. The act of pollution was an accident and was not a violation per se of the statute. (Blunt-Fla)
W69-05965

ELLER V BOARD OF EDUCATION OF BUNCOMBE COUNTY (WATER POLLUTION AS CONSTITUTING A 'TAKING' OF PROPERTY).

242 NC 584, 89 Se 2d 144-146 (1955).

Descriptors: *Water pollution, *North Carolina, *Eminent domain, *Damages, Pollutants, Pollution abatement, Local governments, Judicial decisions, Flooding, Water quality, Streams, Obstructions to flow, Septic tanks, Sewage disposal, Mud, Legal aspects, Sewage, Water pollution sources.

Plaintiffs sought to recover damages from the County Board of Education on account of a partial taking or appropriation of their property. The Board, which owned land adjacent to plaintiffs' land, impeded a natural watercourse, causing water and mud to back up onto plaintiffs' property, and allowed sewage from a septic tank to flow into the watercourse, thereby contaminating plaintiffs' water supply and making their dwelling house unfit for habitation. The Board moved to dismiss the complaint for failure to state a cause of action. The court held that the question whether the backing up of water constituted a taking turned upon whether the property value was substantially impaired by such backup. If plaintiffs' spring and dwelling house were rendered unfit for use because of the sewage inflow, there would be a 'taking' to the extent of any resulting impairment in value. Judgment overruling the demurrer was affirmed. (Kahle-Fla)
W69-05986

06. WATER RESOURCES PLANNING

6A. Techniques of Planning

THE STRATEGY OF BUILDING MODELS OF COMPLEX ECOLOGICAL SYSTEMS,
Canadian Dept. of Forestry, Victoria (British Columbia).
Crawford S. Holling.
Systems Analysis in Ecology, K E F Watt (ed), Chap 8, pp 195-214, Academic Press, New York, 1966. 4 fig, 25 ref.

Descriptors: *Systems analysis, *Ecosystems, *Mathematical models, Ecology, Digital computers, Computer models, Predation, Insects.
Identifiers: Experimental component analysis, Praying mantis, Houseflies, Holling's invertebrate model, Difference equations.

Digital computers are suited to integrate pertinent relationships of components of complex ecosystems and to handle spatial effects, temporal influences, thresholds, limits, and discontinuities. Ideally, a systems model should be specific yet have adequate generality to handle diverse ecological systems. Such model can be formulated by 'experimental components analysis' developed on the conviction that the property of a complex process can be elucidated by consideration of the action and interaction of discrete components. Components existing in all examples of the process are considered basic, while those present in only some are called subsidiary. Identification of components involves general observations and experimentation. The operation and limitation of the experimental components analysis are illustrated by use of examples from predation studies. The 'invertebrate model' demonstrates the operation of the analysis. A full model can be constructed from difference equations derived from fragemental equations describing postulates about the isolated actions and interactions of the components. Generalization of some portions (ie, thresholds) of the model is necessary especially when only one species has been used in the critical experiments. Therefore, the universality of the thresholds can be maintained only by the inclusion of switching procedures in the computer program describing the attack cycle. (Watts-Wis)
W69-05713

THE ANALYSIS OF DETERMINATION IN POPULATION SYSTEMS,
Forest Service (USDA), New Haven, Conn. Northeastern Forest Experiment Station.
D. Gordon Mott.
Systems Analysis in Ecology, K E F Watt (ed), Chap 7, pp 179-194, Academic Press, New York, 1966. 4 tab, 12 ref.

Descriptors: *Regulation, *Systems analysis, *Population, *Analysis, Life history studies, Insects, Insect control, Ecology.
Identifiers: Gypsy moth, Variance analysis, Covariance analysis.

In understanding the structure and operation of a natural dynamic system, it is desirable to know what happens under natural regulation of the system other than what can happen under rigid experimental control of most of the variables. Adopting the hypothesis that variation in a (dependent) variable in the natural system must be traceable to variations among the determining (independent) variables, the natural system may be divided into sub-systems and the natural interactions between them may be resolved. An example of fluctuations in gypsy moth populations is used to illustrate the general method of analysis and to demonstrate the importance of considering both variance and covariance of indepent variables to determine the most important regulatory influences on the population. In general, the variance in the dependent variable in the natural system is equal to the sun of the variances in the independent variables plus twice the sum of the covariances between the independent variables. Covariances will be nonzero whenever variables are correlated. Such covariance may result from direct connection between variables or mutual connection of variables to an outside factor. (Watts-Wis)
W69-05714

THE RANGE OF CHOICE IN WATER MANAGEMENT. A STUDY OF DISSOLVED OXYGEN IN THE POTOMAC ESTUARY,
Resources For the Future, Washington, D.C.
For primary bibliographic entry see Field 05G.
W69-05715

WATER QUALITY MODELS OF THE ESTUARY,
Federal Water Pollution Control Administration, Washington, D. C.
For primary bibliographic entry see Field 05G.
W69-05716

RESERVOIR SYSTEM SIMULATION,
Resources for the Future, Inc., Washington, D. C.
For primary bibliographic entry see Field 05G.
W69-05717

MATHEMATICAL ANALYSIS: DESIGN OF THE SIMPLE VALLEY PROJECT,
Harvard Univ., Cambridge, Mass.
Robert Dorfman.
Economics of Watershed Planning, The Iowa State University Press, Ames, Chapter 14-B, pp 217-229, 1961. 13 p, 1 fig.

Descriptors: *Linear programming, Economic efficiency, Mathematical models, *River basin development, Multiple-purpose projects, Reservoir design, Irrigation design, Seasonal, Hydroelectric plants, Water demand, Water distribution (Applied), Benefits, Digital computers.
Identifiers: Deterministic hydrology, Trial and error, Quasi-linear programming.

A trial and error method was used to find the optimal reservoir sizes and energy and irrigation outputs for a linear programming model of a hypothetical river basin. The basin consisted of 2 reservoirs, an irrigation district and a power plant. Deterministic inflows for 2 reasons were assumed. Non-negativity, flow conservation and power constraints, (wet and dry season), were defined. The objective function was a function of 4 variables (the 2 reservoir sizes and annual irrigation and energy outputs). By trial and error, values for the reservoir sizes were assumed, the maximum net benefit from energy and irrigation releases was computed, and differentiated with respect to both reservoir sizes to check whether an increase or decrease in the respective dam sizes was required for the next trial. It was concluded that this 'quasi-linear programming' approach would require digital computors to solve complex basin problems. (See W69-05719). (Gysi-Cornell)
W69-05719

WATER QUALITY MANAGEMENT AND SOME POLICY MODELS,
Georgia Inst. of Tech., Atlanta; Clemson Univ., S. C.
For primary bibliographic entry see Field 05G.
W69-05722

OPTIMAL OPERATING RULES FOR MULTI-RESERVOIR SYSTEMS,
Massachusetts Inst. of Tech., Cambridge.
For primary bibliographic entry see Field 04A.
W69-05723

MATHEMATICAL PROGRAMMING MODELS APPLIED TO A WATER RESOURCE SYSTEM,
Massachusetts Inst. of Tech., Cambridge.
For primary bibliographic entry see Field 04A.
W69-05725

COLLECTIVE FACILITIES IN WATER QUALITY MANAGEMENT,
Ohio State Univ., Columbus; and Resources for the Future, Inc., Washington, D. C.
For primary bibliographic entry see Field 05G.
W69-05726

DISSOLVED OXYGEN IN THE DELAWARE ESTUARY,
Resources for the Future, Inc., Washington, D. C.
For primary bibliographic entry see Field 05G.
W69-05727

THE DELAWARE ESTUARY STUDY,
Resources for the Future, Inc., Washington, D. C.
For primary bibliographic entry see Field 05G.
W69-05728

DESIGN OF WATER-RESOURCE SYSTEMS,
Harvard Univ., Cambridge.
For primary bibliographic entry see Field 04A.
W69-05729

MATHEMATICAL MODELS: A STOCHASTIC SEQUENTIAL APPROACH,
Harvard Univ., Cambridge, Mass.
For primary bibliographic entry see Field 04A.
W69-05730

REGIONAL RAIN MODELS WITH SPACE- AND TIME-CORRELATED STRUCTURE,
Matson Research Corp., San Francisco, Calif.
For primary bibliographic entry see Field 02B.
W69-05731

MATHEMATICAL SIMULATION OF THE ESTUARINE BEHAVIOR AND ITS APPLICATIONS,
General Electric Co., Philadelphia, Pa; and Federal Water Pollution Control Administration, Philadelphia, Pa.
For primary bibliographic entry see Field 05G.
W69-05732

AN OPERATIONS RESEARCH APPROACH TO BASIN SEDIMENT CONTROL,
Johns Hopkins Univ., Baltimore, Md.
For primary bibliographic entry see Field 02J.
W69-05733

OPTIMUM MANAGEMENT OF A COMBINED PUMPED HYDRO AND IRRIGATION STORAGE FACILITY,
Stanford Research Inst., Menlo Park, Calif.
For primary bibliographic entry see Field 04A.
W69-05734

SYSTEMS ANALYSIS,
Harvard Univ., Cambridge, Mass. Harvard Water Program.
For primary bibliographic entry see Field 06B.
W69-05742

ECONOMIC EVALUATION OF WATER, PART V: MULTIREGIONAL INPUT-OUTPUT TECHNIQUES AND WESTERN WATER RESOURCES DEVELOPMENT,
California Univ., Berkeley.
For primary bibliographic entry see Field 06B.
W69-05754

EXPERIENCE WITH AND EVALUATION OF CRITICAL PATH METHODS,
Brown and Root, Inc, Houston, Tex.
For primary bibliographic entry see Field 08A.
W69-05817

OPERATIONAL HYDROLOGY USING RESIDUALS,
Federal Water Pollution Control Administration, Washington, D. C.
George K. Young, and William C. Pisano.
Proc, Amer Soc Civil Eng, Vol 94, No HY4, pp 909-923, July 1968. 15 p, 2 fig, 6 tab, 2 append.

Descriptors: *Simulation analysis, *Synthetic hydrology, Markov processes, Hydrologic equation, Correlation analysis, Data processing, Flow rates, Water quality.
Identifiers: Stationary residuals.

An algorithm for simulating multisite streamflow or water quality data for hydrologic management and planning studies was demonstrated. Multiple site flow or quality data were operated on using a scheme of Yevdjevich. Stationary residuals were represented using a matrix representation attributable to Matalas. Synthetic residuals were generated which in turn were transformed into operational hydrology. The development presumed a Markovian structure and considered serial and cross correlation between stations. It was concluded that method for generating operational hydrology was successful, that means, standard deviations, cross correlations and the Markovian structure in the residuals were preserved. It was concluded that water quality as well as water quantity could be simulated. (Gysi-Cornell)
W69-05847

HYDROLOGIC SIMULATION IN WATER-YIELD ANALYSIS,
Corps of Engineers, Sacramento, Calif.
For primary bibliographic entry see Field 02E.
W69-05849

USE OF INTERRELATED RECORDS TO SIMULATE STREAMFLOW,
Corps of Engineers, Sacramento, Calif.
For primary bibliographic entry see Field 02E.
W69-05850

DIGITAL COMPUTERS AND ENVIRONMENTAL CONTROL,
Cornell Univ., Ithaca, N. Y.
For primary bibliographic entry see Field 05G.
W69-05855

ANALOG MODELS FOR FLOOD CONTROL SYSTEMS,
California Univ., Berkeley.
For primary bibliographic entry see Field 04A.
W69-05856

WATER RESOURCE SYSTEMS ANALYSIS,
North Carolina Univ., Chapel Hill.
Maynard M. Hufschmidt.
Proc, 2nd Annu Amer Water Resources Conf, Chicago, pp 460-466, Nov 20-22, 1966. 7 p, 10 ref.

Descriptors: *Systems analysis, *Water resources, Simulation analysis, Economics, Leontief models, Rainfall simulators, Decision making, Social aspects, River systems.

The current (1966) status of systems analysis techniques in water-resource planning was reviewed. The use of computer-based simulation models in present studies, and the possibility of future integration of rainfall, surface flow, ground flow and estuarine models into a 'ground system', 'physical-technologic' model was discussed. 'Social Economic' models of the regional Leontief-type input-output form were described. Probable extensions of systems analysis techniques for improved decision-making were suggested. (Gysi-Cornell)
W69-05857

A NONLINEAR HYDROLOGIC SYSTEM RESPONSE MODEL,
Illinois Univ., Urbana.
For primary bibliographic entry see Field 02A.
W69-05858

SIMULATION OF THE EVOLUTION OF DRAINAGE-BASIN NETWORKS WITH A DIGITAL COMPUTER,
Clarkson Coll. of Technology, Potsdam, N. Y.
For primary bibliographic entry see Field 02E.
W69-05859

MATHEMATICAL MODEL FOR FLOOD RISK EVALUATION,
Cornell Univ., Ithaca, N. Y.
For primary bibliographic entry see Field 04A.

W69-05860

COMPUTER SIMULATION OF ESTUARIAL NETWORKS,
California Univ., Berkeley; Public Health Service, San Francisco, Calif.; and Water Resources Engineers, Inc., Lafayette, Calif.
For primary bibliographic entry see Field 02L.
W69-05861

LEAST SQUARES ESTIMATION OF MIXING COEFFICIENTS,
Vanderbilt Univ., Nashville, Tenn.; and Boeing Co., Huntsville, Ala.
Edward L. Thackston, James R. Hays, and Peter A. Krenkel.
Proc, Amer Soc Civil Eng, Vol 93, No SA3, pp 47-58, June 1967. 12 p, 1 tab, 15 ref.

Descriptors: *Mathematical models, *Least squares method, *Mixing, *Streamflow, Computer programs, Digital computers, Regression analysis, Sanitary engineering, Time of concentration, Parametric hydrology, Estimating.
Identifiers: Mixing coefficients, Travel times.

The principle of least squares estimation of nonlinear parameters as a general tool in mathematical modeling was shown to be applicable to many problems in sanitary engineering. A digital computer program for accomplishing the procedure was described, and results were illustrated for the example of estimating mixing coefficients and mean travel times for measured time-concentration curves. An examination of existing estimation procedures indicated their unreliability and inaccuracy. The results of comparative fit of several methods to several hundred curves were presented. A trial-and-error procedure, which could be used in the absence of a digital computer, was outlined. (Gysi-Cornell)
W69-05862

MECHANICS OF A MATHEMATICAL GROUND-WATER MODEL,
Wyoming Univ., Laramie; and Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 02F.
W69-05863

GROUNDWATER MANAGEMENT FOR THE NATION'S FUTURE--COMPUTER SIMULATION OF GROUNDWATER BASINS,
International Business Machines Corp., Los Angeles, Calif.; and California State Dept. of Water Resources, Los Angeles.
For primary bibliographic entry see Field 04B.
W69-05864

AN INVESTIGATION OF THE EMPLOYMENT OF MULTIPLE OBJECTIVES IN WATER RESOURCES PLANNING,
South Dakota State Univ., Brookings. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 06B.
W69-05882

RELIABILITY ESTIMATES FOR A STORAGE RESERVOIR WITH SEASONAL INPUT,
Slovak Academy of Sciences, Bratislava (Czechoslovakia). Inst. of Hydrology and Hydraulics.
Vit Klemes.
J Hydrol, Vol 7, No 2, pp 198-216, Jan 1969. 19 p, 6 fig, 1 tab, 6 ref.

Descriptors: *Water management (Applied), *Water storage, *Water supply, *Reliability, *Statistical methods, Reservoir yield, Optimization, Probability, Reservoir operation, River forecasting, Usable storage, Computers, Digital computers.
Identifiers: Reservoir reliability, Water supply probability.

Reliability of storage reservoir operation may be judged from 3 different points of view. One may consider the number of failure years within a given period, or the total duration of failures, or the deficit of water not supplied to the consumer. According to the criterion adopted, 3 different characteristics of reliability can be used, in particular, the occurrence-, time-, and quantity-based 'certainty'. While certainty is represented by a single value if an unlimited period of time is considered, it has a distribution in case of a finite period. A method is presented for determining the distribution of certainty of any of the 3 above mentioned types, for a reservoir with seasonal input, constant or variable draft, and with mean annual inflows forming a random sequence. The method employs Moran's discrete approximation to a continuous distribution and Gould's approach to determination of transition probabilities.
W69-05906

MARKOV CHAIN STORAGE MODELS FOR STATISTICAL HYDROLOGY,
Cornell Univ., Ithaca, N. Y.
For primary bibliographic entry see Field 07C.
W69-05917

6B. Evaluation Process

ECONOMICS OF WATERSHED PLANNING,
G. S. Tolley, and F. E. Riggs.
Ames, Iowa State University Press, 1961. 339 p.

Descriptors: Watershed management, *Watersheds (Basins), *Economics, Evaluation, Costs, Cost sharing, Water management (Applied), River basis development, Water rights, Water law, Resource development.

While this book is concerned partly with how small watershed development can best fit into river basin and regional planning, its more general aim is to contribute to a variety of working-level planning decisions that concern technicians, administrators, and legislators in ongoing water-resources development. Examination of small watershed development gives an opportunity to build on the many improvements that have occurred in project formulation and evaluation. Procedures in natural resources planning that previously drew criticism have been improved by developing and enforcing a more adequate theoretical framework and by obtaining personnel well qualified to do planning. Watershed planning teams at once exemplify the merits of an interdisciplinary approach and call attention to problems involving communication between disciplines that still need to be worked on. In order to examine these problems, representatives of public agencies and universities assembled at Knoxville, Tennessee, in June, 1959, for the Symposium on the Economics of Watershed Planning. This book contains the proceedings of the Symposium.
W69-05718

WATER RESOURCES AND ECONOMIC DEVELOPMENT IN THE SOUTH,
Council of State Governments; and Southern Land Economics Research Committee.
Floyd L. Corty, Harold H. Ellis, Joseph J. Moylan, Clyde E. Murphee, and G. S. Tolley.
Conference held at Atlanta, Ga., March 1965. Water Resources and Economic Development in the South, Agr Policy Inst. Series No 16, North Carolina Univ, Aug 1965, 179 p.

Descriptors: *Conferences, *Water resources development, Water demand, Water supply, Legislation, Simulation analysis.

This report contains seventeen articles from the conference proceedings. The primary objectives of the conference were to delineate problems of economic development in the South as they relate to water resources, explore the potentialities for contribution of social science research to solving these problems, and consider how to organize for this contribution in an interdisciplinary setting. Those attending the conference represented university social scientists and physical scientists with experience or interest relating to water resources, legislators, state government personnel with interest in water resources, and other persons from universities and government with concern for the organization of water resources research. (Grossman-Rutgers)
W69-05737

THE FUTURE AGRICULTURAL USE OF WATER - SOUTHERN HUMID REGION,
Tennessee Valley Authority, Wilson Dam, Ala., Agricultural Development Div.
Roger C. Woodworth, and LeRoy Rogers.
In Water Resources and Economic Development in the South, Agr Policy Inst. Series No 16, North Carolina State Univ, Aug 1965, pp 17-24, 7 p, 4 ref.

Descriptors: *Irrigation, *Future planning (Projected), *Land management, *Management, *Agriculture, Water quality control, Feasibility, Economics.
Identifiers: *Southern humid region.

Water supplies originate as rainfall. Water management on land has a marked influence on the minimum flow of streams, as well as on the rate of runoff affecting the degree of flooding. Major categories of agricultural water uses are crop production from natural rainfall and irrigation, and livestock production, and rural home use. From the standpoint of water utilization, a major portion of the available water from rainfall is lost either through transpiration by plants or by evaporation. Most of the water used for agricultural purposes is not reusable. Projections have been made that indicate that the consumption of water for agriculture will be perhaps double that of 1960 by the year 2000, with irrigation being the largest contributor to the increase. (Grossman-Rutgers)
W69-05738

SOME ECONOMIC ASPECTS OF INDUSTRIAL WATER SUPPLY IN THE SOUTH,
Clemson Univ., S. C.
James J. Stepp.
Water Resources and Economic Development in the South, Agri Policy Inst. Series No 16, North Carolina State Univ, pp 25-41, Aug 1965. 17 p, 4 tab, 25 ref.

Descriptors: *Public rights, *Administrative decisions, *Water supply, *Industrial water, Water quality control.

Industrial development is an important factor in maintaining the economic growth of the South. The major industrial uses of water in the United States are steam - electric power production and manufacturing. The availability of usable water is a necessary but by no means a sufficient condition for selecting a site for a manufacturing plant regardless of its size or type. Since in many industrial processes the same water may be used over and over, it is not possible to say that certain specific amounts of water are necessary for the production of certain kinds of products. Most water-quality criteria are stated as minimum or limiting concentrations of various substances in the water. Legal and administrative factors in industrial water supply affect water quality, stream-flow patterns, the physical quantities of water in particular locations at particular times, and the number and quality of available wet-process industrial plant sites. (Grossman-Rutgers)
W69-05739

POTENTIALS OF WATER-BASED RECREATION,
Resources for the Future, Inc., Washington, D. C.
Jack L. Knetsch.

Water Resources and Economic Development in the South, Agr Policy Inst. Series No 16, North Carolina State Univ, pp 43-51, Aug 1965, 9 p, 8 ref.

Descriptors: *Values, *Investment, *Recreation demand, Planning, Expenditures.
Identifiers: Recreation facilities.

Primary values are obtained by the immediate users which are largely outside of the market mechanism. Market values are associated with recreation expenditures. Most figures available on the demand for recreation facilities are for zero and near-zero prices. It is desired that the relationship between demand and non-zero prices be examined. The demand curve has shifted to the right, but changes in the supply curve are unknown. In planning, both demand and supply must be taken into consideration. The characteristics of recreation expenditures, as to the distribution of expenditures among the local recreation areas, areas enroute to the recreation area, and the home areas of the recreationists, should be known when considering recreation investments. (Grossman-Rutgers)
W69-05740

CONTRIBUTIONS OF WATER RESOURCE DEVELOPMENT TO DEPRESSED AREAS DEVELOPMENT,
Appalachia Planning Group.
John C. H. Lee, Jr.
Water Resources and Economic Development in the South, Agr Policy Inst. Series No 16, North Carolina State Univ, Aug 1965, pp 67-79. 13 p, 1 tab.

Descriptors: *Cost-benefit analysis, *Planning, *Water resources development, *Investment, Governments.
Identifiers: *Appalachian Regional Development Act of 1965, *Corps of Engineers.

The Corps of Engineers designs and constructs multiple-purpose reservoirs and local protection projects, and improves streams for navigation. These projects are being carried out under the Appalachian Regional Development Act of 1965. The effect of such water resource investment on depressed areas is examined. Reports on proposed projects consider benefit-cost ratios which show that benefits exceed costs from a national point of view. Annual reports of the Chief of Engineers give statistics on how the projects are doing. Three case studies are discussed to show the effect of the projects on depressed areas. Procedures for the development of the projects and analyzing the resultant benefits are presented. (Grossman-Rutgers)
W69-05741

SYSTEMS ANALYSIS,
Harvard Univ., Cambridge, Mass. Harvard Water Program.
Maynard M. Hufschmidt.
Water Resources and Economic Development in the South, Agr Policy Inst. Series No 16, pp 81-90, Aug 1965, 10 p, 17 ref.

Descriptors: *Systems analysis, *Model studies, *Equipment, Project planning.

Systems analysis is the methodological study of the important relationships among the individual elements of a process, structure, or problem. The orderly study of, for example, dams, power plants, canals, aqueducts, pumping and treatment plants for the purposes of flood control, power development, navigation, water supply, and water quality improvement comprises a set of important relationships in water-resource systems analysis. Two approaches to the solution of water-resource design problems are (1) mathematical models and (2) simulation studies. Two types of mathematical models are examined. First is the study of the arithmetic relationships among stochastic inputs and non-stochastic outputs. Second is the study of non-stochastic inputs (e.g. streamflow) in the deterministic model. Simulation models are also discussed. Through the use of systems analysis and the computer water resource planning would converge on the optimal plan. (Grossman-Rutgers)
W69-05742

CHICAGOLAND DEEP TUNNEL SYSTEM FOR POLLUTION AND FLOOD CONTROL: FIRST CONSTRUCTION ZONE, DEFINITE PROJECT REPORT.
Harza Engineering Co., Chicago, Ill.; and Bauer Engineering, Inc., Chicago, Ill.
For primary bibliographic entry see Field 05G.
W69-05743

THE RIVER BASIN DEVELOPMENT CONCEPT, WATER RESOURCES PLANNING IN THE PACIFIC NORTHWEST,
Bonneville Power Administration, Portland, Oreg.
Warren Marple.
Oregon State University, Seminar proceedings, July 1965, pp 43-53. 11 p.

Descriptors: *River basin development, *Regional analysis, *Pacific Northwest U. S., *Planning, Coordination, Technology, Human population, Oregon, Conservation, Interagency cooperation, History.

The report describes the river basin concept of water resource planning which has been adopted in the Pacific Northwest with its comprehensive and coordinated approach; outlines the evolution of regional planning in the Pacific Northwest over the past thirty years; summarizes the current situation and planning needs; and, suggests direction for the region's planning efforts. The geographic planning unit is the river basin, including consideration of related land resources. 'Comprehensive' planning embraces all aspects and uses of water. 'Coordinated' planning includes all governmental and non-governmental agencies concerned with water. The organizational structure of planning must accommodate agencies and their functions, and provide for dialogue with the public. Comprehensive plans for all river basins in the U. S. will be completed in the early 1970's. The report describes present planning, planning needed, changing needs due to population growth, effects of science and technology on planning, expanding geographic scope due to technology and population pressures, and Oregon's conservation programs. It recommends: a Columbia River Basin Commission be established or CBIAC be strengthened; states share planning responsibilities; state research be increased; long-range objectives be formulated; and, that coordination exist between water resource planning and other planning. (Gossen-Chicago)
W69-05746

WATER LAW, POLITICS, AND ECONOMICS: IS OUR SYSTEM OF PUBLIC DISTRICTS OUTMODED,
Oregon State Legislature, Salem.
Cornelius Bateson.
Oregon State University, Seminar Proceedings, July 1965, pp 65-71. 7 p.

Descriptors: *Oregon, *Water districts, *Multiple purpose, History, Legislation, Watershed management, Local governments, Water utilization, Taxes, Ohio, Political aspects.
Identifiers: States water rights conflicts.

Oregon has a proliferation of taxing districts in the field of water. The history of the legislation that enacted them is described. The lack of an overall water law is discussed. The effect of this lack is an inefficient utilization of water. The report recognizes two alternative actions. The first is to expand the powers of one or more varieties of existing districts. The second is to create a new variety of districts based upon the multiple-use concept. The first alternative is proven unacceptable. The second is described. Local citizens should form the district, which would be subject to the State Water Resources Board and the general state law. The district must have a watershed approach. Its powers must include all ten beneficial water uses recognized by Oregon statute. It must have the power to build, develop, and operate engineering works and to supply water both within and without the boundaries of the district. It must maintain realistic taxing, assessment, rating, and bonding. Ohio was first to enact a multiple-purpose district. Its history is briefly described. Fear of taxation, opposition from established districts, and ignorance of the problem are three reasons that have prevented enactment of this special district; but if the district is not formulated, water will continue to be wasted and Oregon may lose part of its water rights to California. (Gossen-Chicago)
W69-05747

WATER LAW, POLITICS, AND ECONOMICS: WATER RESOURCES AND PUBLIC REGULATIONS OF THEIR USES,
Reed Coll., Portland, Oreg.
Charles McKinley.
Oregon State University, Seminar proceedings, July 1965, pp 83-99. 17 p, 20 ref.

Descriptors: *Water control, *Federal jurisdiction, *State jurisdiction, *Legal aspects, Legislation, Judicial decisions, Navigation, Flood control, Hydroelectric project licensing, Federal Power Act, Underground streams, Water rights, Water pollution control, Local governments, Flood plain zoning, Political aspects.
Identifiers: U. S. Army Corps of Engineers.

The report gives the history of the federal government's dominance over state and local governments in water resources control. Discussion includes the court case of Gibbons v. Ogden, the changing notion of navigation, activities of the Army Corps of Engineers, the flood control Act of June 1936, the development of the Federal Power Commission and its responsibility for regulation of navigation, development of public interest in federal hydroelectric policy, The Federal Power Act of 1920, the expansion of geographic jurisdiction of the Federal Power Commission and the federal government, and the FPC's uses and abuses of its licensing functions. The states regulate who shall use water for other purposes than navigation. Their jurisdiction also applies to underground waters. In most western states a state officer, rather than the courts, decides who has water rights. The history of these state privileges is given. State neglect of control of groundwater apportionment is documented. The Special Committee appointed by F. D. Roosevelt published a proposed model law for western states, which is summarized. Pollution legislation and shifting responsibility for pollution control from state to federal to local levels are described. The possibilities and the economic and political difficulties of zoning flood plains are suggested. (Gossen-Chicago)
W69-05748

ECONOMIC IMPACT OF WATER RESOURCE DEVELOPMENT,
North Dakota State Univ., Fargo.
Thor A. Hertsgaard.
Completion Report, March 26, 1969. 31 p, 5 tab, 5 ref. OWRR Project B-002-NDAK.

Descriptors: Economic impact, *Economic prediction, *Input-output analysis, Income, Resources, *Irrigation, North Dakota.
Identifiers: Garrison Diversion Irrigation Project, Dickinson (North Dakota).

Expenditures data were collected from a sample of farms, nonfarm firms, households, and local units of government in a seven-county area of southwestern North Dakota. These data were incorporated in an input-output analysis to obtain measures that can be used to estimate the economic impact of water resource development in an area. Thirty sectors were delineated and esti-

mates were made of the dollar volume of expenditures by the respective sectors to other sectors within each of four trade areas in the seven-county area. Estimates were also made of the expenditures of each of the sectors that went to the central city of the seven-county area and of the expenditures made outside the area. In addition to the use of conventional input-output analysis, regression analysis was employed to explore the relationship between gross income of the economic unit (firm or household) and the level of expenditure to each of the respective sectors. Although only cross-sectional data were available, the analysis provided statistically significant evidence that allocation of marginal changes in income of economic units can be predicted with a sufficient degree of accuracy to provide useful projections of the economic impact of water resource development.
W69-05751

ECONOMIC EVALUATION OF WATER, PART V: MULTIREGIONAL INPUT-OUTPUT TECHNIQUES AND WESTERN WATER RESOURCES DEVELOPMENT,
California Univ., Berkeley.
H. Craig Davis.
Calif Univ Water Resources Center Contribution No. 13, Berkeley: Sanitary Engineering Research Lab., February 1968. 142 p, 17 tab, 3 append, 148 ref. OWRR Project B-017-CAL.

Descriptors: *Economics, Water resources, Western U.S., *Regional input-output models, *Evaluation.
Identifiers: Multiregional water interdependencies.

The objectives of the study are (1) to set forth the methodology for and problems encountered in the construction of an interregional input-output table model based upon already existing Western state input-output tables, and (2) to examine the possible applications of the model to Western water resource development. Of the eleven continental Mountain and Pacific states, tables existed for six: Arizona, California, New Mexico, Oregon, Utah, and Washington. These tables were reprogrammed to effect conformability and two additional tables were constructed to represent the remaining states. The eight regions (Nevada, Idaho, Montana, and Wyoming were treated as one region) were then linked via the Leontief-Strout gravity flow model. A set of water coefficients was prepared for each of the regions and a multiregional water content matrix constructed. Applications of the matrix resulted in the calculation and/or discussion of (a) interregional water dependencies, (b) interregional water withdrawal multipliers, (c) interregional embodied water transfers, and (d) water-constrained projections. The study includes an elementary discussion of regional and interregional input-output and contains a bibliography of 148 references.
W69-05754

APPLICATION OF ELECTRONIC COMPUTERS TO IRRIGATION AND DRAINAGE SYSTEM PROBLEMS,
Bureau of Reclamation, Denver, Colo.
For primary bibliographic entry see Field 02A.
W69-05803

WATER DISTRIBUTION SYSTEMS ANALYSIS,
Technion - Israel Inst. of Tech., Haifa; Massachusetts Inst. of Tech., Cambridge; and Maguire (Charles A.) and Associates, Boston, Mass.
Uri Shamir, and Charles D. D. Howard.
Proc, Amer Soc Civil Eng, Vol 94, No HY1, pp 219-234, Jan 1968. 16 p, 2 fig, 16 ref, 1 append.

Descriptors: *Water distribution (Applied), *Distribution systems, *Systems analysis, Hydraulic design, Networks, Hydraulic gradient, Flow resistance, Pumps, Valves, Pipes, Steady flow, Digital computers, Decision making, Water conveyance.
Identifiers: Newton-Raphson technique.

A generalized method was presented for solving nonlinear networks and studying their sensitivity under steady-state flow conditions. The network could contain elements other than pipes, such as pumps and valves, and unknowns could be combinations of heads, consumptions or element resistances. Conditions for convergence of the Newton-Raphson iterative scheme and the possibility of insolvable problems were discussed. The method's flexibility for handling changes in input data was used in a time-sharing environment as an on-line tool to assist engineering design and decision-making. It was concluded that for effective use, large capacity, high speed computers were necessary. (Gysi-Cornell)
W69-05848

FLOOD PROOFING IN A FLOOD PLAIN: A STOCHASTIC MODEL,
Engineering Construction Corp., Ltd, Bombay (India); and Carnegie Inst. of Tech., Pittsburgh, Pa.
For primary bibliographic entry see Field 04A.
W69-05851

MATHEMATICAL REPRESENTATION OF AN URBAN FLOOD PLAIN,
Carnegie Inst. of Technology, Pittsburgh, Pa.
For primary bibliographic entry see Field 04A.
W69-05852

GOVERNMENT AND WATER RESOURCES DEVELOPMENT,
Colorado State Univ., Fort Collins. Dept. of Economics.
For primary bibliographic entry see Field 06D.
W69-05878

AN INVESTIGATION OF THE EMPLOYMENT OF MULTIPLE OBJECTIVES IN WATER RESOURCES PLANNING,
South Dakota State Univ., Brookings. Dept. of Agricultural Economics.
Robert Rehm Werner.
Doctoral thesis, Department of Agricultural Economics, South Dakota State University, 1968. 161 p, 4 tab, 107 ref.

Descriptors: *Project planning, Economic efficiency, Administration.
Identifiers: *Susquehanna River Basin, *Multiple objective planning.

Water resources planning has adhered to the criteria of economic efficiency. The inclusion of multiple objectives simultaneously in water resources planning can result in plans that optimize the satisfactions of peoples' total desires. Involved is the determination of (1) the theoretical implications of employing multiple objectives; (2) the degree to which the employment of multiple objectives is compatible with quantitative analysis; and (3) the adequacy of the existing institutional structure to administer multiple objective planning. The contemporary planning efforts in the Susquehanna River Basin Study were reviewed. (Grossman-Rutgers)
W69-05882

THE VALUE OF WATER FOR IRRIGATION IN THE KANSAS RIVER VALLEY,
Kansas State Univ., Manhattan. Dept. of Agricultural Economics.
David M. Nelson, and Wilfred H. Pine.
Contrib No 20, Kans Water Resources Res Inst Proj Completion Rep, 1968. 45 p, 6 fig, 14 tab, 14 ref. OWRR Project No A-007-KAN.

Descriptors: *Irrigation efficiency, *Kansas, Crop response, Crop production, Cost-benefit analysis, Costs, Prices, Corn (Field), Corn belt, Productivity, Profit, Economic efficiency, Specialty crops.
Identifiers: Kansas River Valley, Irrigation costs.

The value of water for irrigation in the Kansas River Valley was studied to determine efficiency of use and for water allocation evaluations. In summer 1966, 27 of the 45 sampled farms irrigated 59 fields of corn. The average investment in irrigation equipment and facilities was $16,879 or $140 per irrigated acre. Fixed annual costs averaged $1,100 per farm and variable costs averaged $1,163 or $26 per acre at $2.07 per acre-in. Yields in 1966, a dry year, averaged 46.8 bushels per acre higher than non-irrigated corn, or $7.11 per acre added income. Estimated returns indicated that irrigation would have allowed increased profits during only 5 of the 15 yrs 1951-1956. From 1951-1966 irrigation was, on the average, marginal; at 1966 prices, irrigation water had zero average value for the average farmer. Irrigation of specialty crops would probably be more profitable. (Knapp-USGS)
W69-05919

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

CONSUMER RESPONSES TO PRICES OF RESIDENTIAL WATER,
Georgia Univ., Athens. Dept. of Agricultural Economics.
Ronald M. North.
AWRA Journal Series Paper No. 185, American Water Resources Conference, San Francisco, California, Nov 10, 1967. 19 p, 5 tab, 1 fig, 5 ref.

Descriptors: *Water demand, *Elasticity of demand, *Prices, *Income, Statistical methods, Investment, Sampling.
Identifiers: *Georgia.

Household water use was correlated with economic variables that were expected to affect the quantity of water used and the expenditure for water services. Cross sectional data was obtained from a stratified, random sample of households in Georgia. The important variables that affected the use of household water were found to be prices, family income, market value of residence, size of family, and irrigable lawn area. Price and income elasticities of the demand for water were estimated. The inelastic price elasticity implies that by increasing price, household water usage can be decreased without reducing total revenues. (Grossman-Rutgers)
W69-05881

COST OF MUNICIPAL AND INDUSTRIAL WELLS IN ILLINOIS, 1964-1966,
Illinois State Water Survey, Urbana.
J. P. Gibb, and E. W. Sanderson.
Ill State Water Surv Circ 98, 1969. 22 p, 12 fig, 8 ref.

Descriptors: *Water wells, *Cost analysis, *Water management (Applied), Regression analysis, Least squares method, Aquifers, Water yield, Costs, Construction costs, Estimated costs, Installation costs, Total costs, Pumps, Wells, Well casings, Drilling.
Identifiers: Cost-depth relationships (Water wells), Well drilling costs, Well installation costs.

The cost of water wells and pumps was determined from information obtained for 143 municipal and industrial water-supply wells drilled in Illinois during 1964-66. Regression analyses using the method of least squares show that the cost of wells is directly related to depth and the cost of pumps is directly related to capacity. A series of cost-depth relationships which plot as straight lines on log-log graph paper are developed for wells tapping sand and gravel aquifers; shallow sandstone, limestone, or dolomite aquifers; and deep sandstone aquifers. Similar graphs relating pump cost to capacity are also presented for various operating heads. Sample cost estimates are given for each type of well and pump. These data are intended to establish orders of magnitude for comparison purposes and do not substitute for more detailed engineering estimates. (Knapp-USGS)
W69-05910

COST OF RESERVOIRS IN ILLINOIS,
Illinois State Water Survey, Urbana.
J. H. Dawes, and Magne Wathne.
Ill State Water Surv Circ 96, 1968. 22 p, 4 fig, 10 ref.

Descriptors: *Reservoir construction, *Cost analysis, *Water management (Applied), Regression analysis, Least squares method, Streams, Streamflow, Water yield, Costs, Construction costs, Estimated costs, Installation costs, Total costs, Dams, Land, Reservoirs, Reservoir sites.
Identifiers: Reservoir costs, Reservoir construction costs.

The determination of reservoir cost is essential to the analysis of alternative costs in the development, use, and management of water resources. An analysis of single and multipurpose reservoir costs produced a relationship allowing rapid determination of the cost of stored water. The empirical expression for project cost of single or multipurpose reservoirs includes construction cost, engineering services, contingencies, and land costs. A complete development of a cost expression and a graphical solution are presented. The estimating of project costs of reservoirs is necessary to the examination of alternatives in water resource development, but this type of estimating does not take the place of detailed engineering studies and can be used only for screening alternatives. (Knapp-USGS)
W69-05915

UNITED STATES V 11.48 ACRES OF LAND, ETC (COMPENSATION FOR CONDEMNED RIPARIAN RIGHTS).

212 F 2d 853-855 (5th Cir 1954).

Descriptors: *Florida, *Condemnation, *Riparian rights, *Compensation, Judicial decisions, Condemnation value, Navigable waters, Ownership of beds, Severance, Riparian land, Eminent domain, Easements, Legal aspects, Right-of-way, United States, Federal government, Remedies, Rivers.

The federal government condemned certain river bottom lands adjacent to the plaintiff's riparian holdings. The condemnation of the fee simple ownership of the submerged lands included all easements and interests not specifically excepted from the taking. The lands taken included the river bed to the point of the high water mark touching the plaintiff's uplands. The plaintiff sought just compensation for the condemned riparian rights. In affirming a compensation award for the plaintiff, the court noted that the value of an easement to underwater lands cannot be ascertained without reference to the dominant estate to which it is attached. The dimunition in the value of the upland estate arises by reason of the taking of the riparian rights appurtenant thereto. The plaintiff's riparian rights were not simply subjected to the government's dominant servitude over navigable waters, but those rights were permanently and irrevocably taken. The Fifth Amendment guaranteed the appellee the right to just compensation for such an absolute taking. (Blunt-Fla)
W69-05964

6D. Water Demand

ASSESSING UPLAND RESERVOIRS USING A DAILY FLOW MODEL,
Federal Water Pollution Control Administration, Washington, D. C.
For primary bibliographic entry see Field 02E.
W69-05632

THE DEMAND FOR WATER: SOME EMPIRICAL EVIDENCE ON CONSUMERS' RESPONSE TO A COMMODITY UNCERTAIN IN SUPPLY,
Pennsylvania Univ., Philadelphia.
Stephen J. Turnovsky.
Water Resources Res, Vol 5, No 2, pp 350-361, Apr 1969. 12 p, 4 tab, 15 ref, 1 append. Sponsored by RFF and FWPCA.

Descriptors: *Water demand, *Mathematical models, Statistical models, Municipal water, Industrial water, Domestic water, Economics, Water distribution (Applied), Water management (Applied), Elasticity of demand, Massachusetts, Droughts.
Identifiers: Drought response (Water demand).

Based on a theoretical model that studies how individuals respond to a commodity uncertain in supply, demand functions are estimated for water in situations where supplies are known to be stochastic. The model is applied to data consisting of a sample of Massachusetts towns, separate functions being estimated for household and industrial demand. Two cross sections are estimated, one for 1962 and one for 1965, the beginning and the end, respectively, of the New England drought. As far as household demand is concerned, price, uncertainty, and particularly housing space are significant, whereas for industrial demand only the first 2 variables are significant. The results also indicate that firms are more responsive than households to both price and uncertainty and that their response to uncertainty lessened as a result of the drought, an implication that agrees with the theoretical model. (Knapp-USGS)
W69-05633

OUTDOOR RECREATION: POLICY ISSUES AND RESEARCH PROBLEMS,
Oregon State Univ., Corvallis. Dept. of Agricultural Economics.
Herbert H. Stoevener, and William G. Brown.
J of Farm Econ, Vol 49, No 5, pp 1295-1304, Dec 1967. 10 p, 1 tab, 2 fig, 12 ref.

Descriptors: *Recreation demand, *Statistical methods.
Identifiers: *Winch method, *Oregon Salmon - Steelhead study, Analytical issues.

Reliance on empirical studies is necessary for policy guidance. The discussion examines the arguments which challenge one idea of quantifying the demand for outdoor recreation. Second, attention is directed to some areas in which additional work appears necessary. Also, analytical issues are raised which appear to be relevant from a policy viewpoint. Empirical results of some available studies are presented. (Grossman-Rutgers)
W69-05736

WATER RESOURCES AND ECONOMIC DEVELOPMENT IN THE SOUTH,
Council of State Governments; and Southern Land Economics Research Committee.
For primary bibliographic entry see Field 06B.
W69-05737

COMMENTS ON WATER TRANSFERS AND RELATED URBAN PROBLEMS,
Idaho Univ., Moscow. Dept. of Hydrology.
Roy E. Williams.
Ground Water, Vol 6, No 6, Nov, pp 6-10, Dec, 1969. 5 p.

Descriptors: *Water transfers, *Social needs, Social mobility, *Social impact, Water resources, Transportation, *Urbanization.
Identifiers: Pacific Northwest.

Heavy development in certain portions of the United States and the growing shortage of additional, readily available water supplies therein have forced planners and hydrologists to resort progressively to more elaborate water supply systems. Among the most elaborate and most expensive systems proposed to date are the various plans for transferring water toward the south from northward flowing Arctic rivers. A considerable portion of this water would be utilized for the expansion of already heavily urbanized areas. Simultaneously, many of the densely populated areas experiencing water shortages are subjected to other, perhaps more complex problems which are, in part, a product of their increasing size. Therefore, the expenditure of large sums of money to supply them with water for indefinite growth merits scrutinous study. An alternative approach designed to minimize both water diversion costs and problems associated with over populated areas is the stimulation of development in carefully selected regions well endowed with water and other natural resources. An investigation of the resources of the Pacific Northwest reveals that it is such an area.
W69-05766

GOVERNMENT AND WATER RESOURCES DEVELOPMENT,
Colorado State Univ., Fort Collins. Dept. of Economics.
Stephen C. Smith.
For main entry see Field 06B, W69-05737. Water Resources and Econ. Develop. in the South, North Carolina Univ., API, Series 16, pp 135-142, Aug 1965. 8 p, 11 ref.

Descriptors: *Federal Government, *Resource development, Legislation, Supply, Demand, Waste disposal.

An emerging function of the government is the planning of water resources development. Usually market forces, through private capture of water, have been the dominating element in water development. This trend has been reversed, especially in regard to the private release of wastes into water courses or evaporation or infiltration ponds. Around these two activities of capture and release of water, government services have increased. The court's definition of state-federal relationships is important, especially in regard to water rights issues. The government's roles in the areas of water disposal, water supply, water resources management, and defining the demand for water service are discussed. Two frames of reference in government's role in water resources development are national planning and planning via an heuristic process. (Grossman-Rutgers)
W69-05878

CONSUMER RESPONSES TO PRICES OF RESIDENTIAL WATER,
Georgia Univ., Athens. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 06C.
W69-05881

FORECASTING WATER DEMAND, AN INTER- AND INTRA-COMMUNITY STUDY,
West Virginia Univ., Morgantown. Bureau of Business Research.
Robert J. Saunders.
W Va Univ Bus and Econ Stud, Vol 11, No 2, Feb 1969. 30 p, 2 fig, 11 tab.

Descriptors: *Water demand, *Municipal water, *Water requirements, Statistical models, Water rates, Water supply, Economics, Costs, Elasticity of demand, Water costs, Water distribution (Applied), Urbanization, Water management (Applied), Regression analysis, Least squares method.
Identifiers: Water demand forecasts, Factor analysis.

A method is presented for forecasting urban water requirements taking into account probable changes in population, economic activity, water-related technology, and demand, based on possible water price changes. Water use data were collected from 75 cities in West Virginia, Ohio, Indiana, Illinois, and Michigan. Each city supplied data on water services, sales, production and population served in 1960. Economic and demographic data for the 75 cities and from 93 of the 124 largest cities of the U.S. were obtained from the U.S. Dept of Commerce. The water sales records of Louisville, Ky., were analyzed. The statistical methods used in the study were principal component analysis and least squares regression analysis. Predictions were made of 1975 water demand on the basis of predicted population, predicted median income, and predicted changes in water prices. (Knapp-USGS)

W69-05900

MUNICIPAL AND INDUSTRIAL WATER USE,
California State Dept. of Water Resources, Sacramento.
Barry P. Brown.
California Dept Water Resources Bull No 166-1, Aug 1968. 106 p, 11 fig, 6 illus, 11 tab, 3 append.

Descriptors: *Water utilization, *California, *Data collections, Municipal water, Industrial water, Consumptive use, Non-consumptive use, Irrigation, Lawns, Recirculated water, Recreation, Water supply, Parks, Urbanization.
Identifiers: Water use trends.

Average monthly per capita water use, in California based generally on 1961-65 records from water agencies serving 54% of the State's population, is highest in June and lowest in January. Departures from the normal pattern were caused by the influence of manufacturing establishments on water use, the length of the growing season, and the sample not being large enough to mask out the unusual monthly values. Per capita water use during the growing season was found to be greatest in the San Joaquin Valley and lowest in the North Coastal area. Residential water use is greater in a hot, arid climate than in a moist, cool climate, but climate has little effect on industrial and commercial water use. Of the 61 cities and areas in the State for which historic annual unit water use data are reported, per capita water use has shown essentially no change in 44 cities and areas, has declined in 13, and has increased in 14. Areas of recent general increase in urban per capita water use are the North Coastal area, the San Francisco Bay area, the Sacramento River basin, the Delta--Central Sierra Basin, and the San Joaquin River basin. Per capita water use is approaching equilibrium in cities in the Central Coastal area, the South Coastal area, and the Tulare Lake basin. The data are summarized by hydrographic areas, counties, and cities. (Knapp-USGS)
W69-05916

A FRAMEWORK FOR THE MULTIPLE USE OF MUNICIPAL WATER SUPPLY AREAS,
Cornell Univ., Ithaca, N. Y.
Emmanuel Theodore Van Nierop.
Water Resources Center Pub, Cornell Univ, July 1966. 153 p, 3 tab, 108 ref, 2 append.

Descriptors: *Multiple purpose reservoirs, *Water supply, *Reservoirs, *Municipal water, *Recreation, Watershed management, Water management (Applied), Water pollution control, Water treatment, Forest management, Water quality control.
Identifiers: *Public access to reservoirs.

The advantages and disadvantages of multiple use of municipal water-supply reservoirs and watersheds are discussed, with particular attention given to recreational uses, including swimming and boating. Strong conflict exists between water-supply agencies, which want to prohibit access to water supplies to prevent contamination, and recreationists, who want access to high-quality, scenically unspoiled water. Recreation in water supplies is a potential health hazard. All activities which involve bodily contact with the water should be prohibited because chlorination is not entirely effective against pathogenic viruses. Timber management can provide both increased water yield and increased revenues, but care must be used to prevent sediment and erosion problems. Data on use, regulation, legal, and financial aspects of multiple use of reservoirs were gathered by mailed questionnaires addressed to the water boards of 202 municipalities, interviews with water works officials in 50 municipalities, and review of professional water management literature. (Knapp-USGS)
W69-05935

6E. Water Law and Institutions

AN APPROACH TO ATTACKING HUMAN-SOCIAL PROBLEMS RETARDING IRRIGATION AND AGRICULTURAL DEVELOPMENT IN LATIN AMERICA,
Inter-American Center for the Integral Development of Land and Water Resources.
For primary bibliographic entry see Field 03F.
W69-05652

WATER RESOURCES AND ECONOMIC DEVELOPMENT IN THE SOUTH,
Council of State Governments; and Southern Land Economics Research Committee.
For primary bibliographic entry see Field 06B.
W69-05737

WATER QUALITY CONTROL: LEGAL AND ADMINISTRATIVE ASPECTS,
For primary bibliographic entry see Field 05G.
W69-05745

THE LEGAL IMPLICATIONS OF ATMOSPHERIC WATER RESOURCES DEVELOPMENT AND MANAGEMENT.
Arizona Univ., Tucson. Weather Modification Law Project Staff.
For primary bibliographic entry see Field 02B.
W69-05756

STATE PROGRAMS FOR ESTUARINE AREA CONSERVATION,
North Carolina Univ., Cahpel Hill. Inst. of Government.
For primary bibliographic entry see Field 02L.
W69-05776

COASTAL STATES GAS PRODUCING CO V STATE MINERAL BD (OWNERSHIP OF STREAM BED).

199 So 2d 554 (3rd Cir Ct App La 1967).

Descriptors: *Ownership of beds, *Louisiana, *Streambeds, Water conveyance, Navigable waters, Riparian rights, Prescriptive rights, State governments, Water law, Legal aspects, Civil law, Judicial decisions.
Identifiers: Inherent sovereignty, *Sovereignty lands.

The question presented is whether an 1885 deed of state lands, which contained a navigable stream, conveyed ownership of the stream bed. The trial court held that the descendants-in-title of the original transferee owned the stream bed contained in the original transfer. The Court of Appeals reversed holding that, in the absence of strong indicia to the contrary, water beds owned by the state by virtue of its inherent sovereignty are not included within conveyed property. After holding that the transfer was not protected by the prescriptive statute, the Court held that due to the doctrine of 'inherent sovereignty, beds of navigable waters are not susceptible of private ownership. Public policy requires that a conveyance including navigable water bottoms within the described area must be strictly construed against the grantee. Therefore a sale of lands would not include a conveyance of navigable water bottoms. (Horner-Fla)
W69-05777

EVOLUTION OF MICHIGAN WATER LAWS,
Michigan State Univ., East Lansing.
Allan A. Schmid.
Evolution of Michigan Water Laws, pp 3-34, 1960. 32 p, 102 ref.

Descriptors: *Michigan, *Riparian rights, *Public rights, *Groundwater, Navigable waters, Reasonable use, Ownership of beds, Legislation, State governments, Water rights, Relative rights, Competing uses, Damages, Remedies, Municipal water, Natural flow, Doctrine, Water quality, Alteration of flow.

Most of the Michigan law comes from court decisions rather than statutory law. In conflicts between water users the court decides what is reasonable between the parties involved. The basis for this reasonableness criterion is the focus of this paper. Generalizations from case law are less than complete since the cases are piecemeal. However, the purpose is not to generalize on the substantive content of all Michigan water law, but only to indicate in a general way how economic change affects the law and how consideration of maintaining economic growth affects the basis for the reasonable character of court decisions affecting the rights of competing users. This analysis is divided into major sections treating surface water law and ground water law. Surface water law is analyzed in terms of: (1), the relative rights of riparians and non-riparians; and (2), the relative rights among riparian owners. Drainage and the laws of pollution are treated only incidentally. (Smith-Fla)
W69-05778

EVOLUTION OF MICHIGAN WATER LAWS-SURFACE WATER: RIGHTS OF RIPARIANS AND NON-RIPARIANS.
Michigan State Univ., East Lansing.
Allan A. Schmid.
Evolution of Michigan Water Laws, pp 3-20, 1960. 18 p, 55 ref.

Descriptors: Water rights, *Michigan, Navigable waters, Dams, Mill dams, Legislation, State governments, *Riparian rights, Riparian land, Municipal water, Industrial water, Recreation, Irrigation water, *Public rights, Ownership of beds, Reasonable use.

The public has certain rights in navigable streams in Michigan. These rights of the public are important because they define the relative rights of riparian owners and non-riparians. A public stream is one where the rights of the private riparian owners are restricted in some manner. To justify such restriction the privileged use must be in the public interest. The question is not what is a private purpose over against a public purpose but is the purpose also public or merely private. This raises the problem of evaluating the degree of public interest in any activity, rather than merely drawing a line between public and private. Today when there are many conflicting but important uses of water such as municipal, industrial, agricultural, and recreational, it is not accurate to say that any one of them may be typified as public while the others are private. The real question is the reasonableness of one use as against another; and this depends on the public interest in the various uses, which should be determined directly and not by any formula for navigability.
W69-05779

EVOLUTION OF MICHIGAN WATER LAWS - SURFACE WATER: RIGHTS AMONG RIPARIAN OWNERS.
Michigan State Univ., East Lansing.
Allan A. Schmid.
Evolution of Michigan Water Laws, pp 20-26, 1960. 7 p, 18 ref.

Descriptors: *Riparian rights, *Reasonable use, *Michigan, Natural flow doctrine, Riparian land, Water rights, State governments, Relative rights, *Remedies, Water utilization, Water pollution, Damages, Alteration of flow, Municipal water, Obstruction to flow, Riparian waters, Competing uses.

The prevailing rule of water rights in Michigan is the riparian doctrine of reasonable use. This is the rule which governs the relative rights of riparian owners. It is important to distinguish between the riparian doctrine modified by the rule of reasonable use and what is often referred to as the natural

flow doctrine. The natural flow doctrine would guarantee riparians the right to have the water pass by unaltered in quantity and quality. Such language is not found in Michigan court decisions, which specifically deny that water must be passed by un-, diminished in quantity and quality. All riparians have a right to some depleting use of the water, but each use must be reasonable when related to the use of other riparians. The remedies available to the riparian owners have a marked effect on the substantive law. The Michigan courts in granting remedies seem to treat a non-user as not entitled to more than nominal damages for past interference, or to any injunctive relief.
W69-05780

EVOLUTION OF MICHIGAN WATER LAWS-GROUND WATER.
Michigan State Univ., East Lansing.
Allan A. Schmid.
Evolution of Michigan Water Laws, pp 26-34, 1960. 9 p, 29 ref.

Descriptors: *Groundwater, *Michigan, Legislation, Municipal water, Percolating waters, Public rights, Water quality, Groundwater movement, Reasonable use, *Wells.

Use of ground water on the property from which it is taken is favored over the transportation of ground water for use at another site. This is similar to the surface water concept of restricting water use to riparian land. In the case of surface water, use on non-riparian land is prohibited even if great public benefit might result. However, in Michigan ground-water decisions the courts do not let private property rights prevent public benefit, such as city use. The courts allow damages to the owner's investment but do not allow the owner to prevent the higher use from being made. The court does not always allow injunctions in the case of surface water, but the principle of allowing damages and providing for shifts to higher use is better established in ground water cases.
W69-05781

WATER AND WATERCOURSES--NAVIGABILITY OF STREAMS IN MISSOURI.
Missouri Univ., Columbia. School of Law.
Robert S. Gardner.
Mo L Rev, Vol 19, No 4, pp 401-412, Nov 1954. 12 p, 59 ref.

Descriptors: *Easements, *Ownership of beds, Riparian rights, *Missouri, *Navigable rivers, Stream beds, Riverbeds, Riparian waters, Eminent domain.

The determination of navigability has two different applications, that which is sufficient for state retention of the title to the river bed, and that which is sufficient to subject private riparian ownership to a public easement. The English common law was that a stream is navigable only as far as the ebb and flow of the tide can be felt. This rule is not suited to America with its great inland streams and rivers. According to the Missouri courts the legislature cannot by statute declare non-navigable streams to be navigable. This is based on the Constitutional prohibition against taking private property without eminent domain proceedings. The test of navigability used to determine state ownership of the river bed is whether the stream in its natural state and with an ordinary volume of water, either constant or regularly recurring with the seasons, is capable of floatage useful to the public. Where navigability is not sufficient to give the state title to the river bed, the riparian owner may be subject to a public easement if the water is periodically capable of floatage to be of sufficient beneficial use. (Batchelor-Fla)
W69-05782

SECTION OF MINERAL AND NATURAL RESOURCES LAW--REPORT OF THE COMMITTEE ON WATER RESOURCES.
American Bar Association, Chicago, Ill. Committee on Water Resources.

Section of Mineral and Natural Resources Law, 1964 Committee Reports, pp 186-210, 1964. 25 p.

Descriptors: *Water law, *Legislation, Judicial decisions, *Administrative decisions, Minnesota, Water resources, Federal-state water rights conflicts, Federal government, State governments, River basin development, Water management (Applied).
Identifiers: Water Pollution Control Act, Water resources research.

The report is divided into three parts, the first dealing with legal developments in the field of water resources in various states and the federal government for the period May 1963 through April 1964. These developments are discussed under the headings of legislation, judicial decisions and administrative action. Although the states reporting are primarily in the western U S, Minnesota is included. Federal developments in the legislative area include pending matters such as the Pacific Southwest Water Plan, the Pacific Northwest-Pacific Southwest Intertie, Federal Water Pollution Control Act amendments, recreation proposals, Small Reclamation Project Act amendments, river basin planning projects, and a water resources research project. Significant federal cases, and administrative actions on Colorado River salinity and the U S-Canada Columbia River Treaty, are also set forth. The second part consists of the report of the Ground Water Management Subcommittee, and the third announces American Bar Association and Congressional action relating to federal-state jurisdictional conflicts in water resources development. (Patterson-Fla)
W69-05783

RES IPSA LOQUITUR AS APPLICABLE IN ACTIONS FOR DAMAGE TO PROPERTY BY THE OVERFLOW OR ESCAPE OF WATER.
J. E. Macy.
11 ALR 2d 1179-1194 (1950).

Descriptors: *Relative rights, *Water law, *Flooding, *Flood damage, Judicial decisions, Legal aspects, Water rights, Adjudication procedure, Water, Water control, Water injury, Water works, Inflow, Seepage, Seepage water, Dams, Flood water, Drains, Sewers, Embankments, Levees, Water management.
Identifiers: Res ipsa loquitur, Rebuttable presumption, Permissible inference.

This annotation collects cases in which a plaintiff sought to recover damages for injury to his property by the incursion of water from some place or container within the defendant's possession or control, where the gravamen of the action was negligence and an issue was whether the doctrine of res ipsa loquitur applied. Only negligence cases are included because it is only in such cases that the doctrine is relevant. After briefly examining the general evidentiary rule of res ipsa loquitur, the annotation deals specifically with cases involving: (1) seepage or inflow of water from an adjacent apartment or building, (2) inflow from a break in a water main or connection, (3) flooding from sewers and drains, (4) flooding from a broken embankment or levee, (5) flooding from a broken dam, (6) flooding as a result of management of gates in a dam. (Carruthers-Fla)
W69-05784

FEDERAL LAW AND SEASHORE ACCRETION.
Michael P. Hebert.
La L Rev, Vol 28, No 4, pp 655-662, June 1968. 8 p, 43 ref.

Descriptors: *Accretion, *Alluvion, *Washington, *Riparian land, Federal jurisdiction, Riparian rights, Seashores, High water mark, Low water mark, Judicial decisions, Littoral legal aspects, State jurisdiction.

This is a case note on Hughes v Washington, 88 S Ct 438 (1967). In Hughes, the plaintiff brought action to quiet title to alluvion formed after 1889, the date of Washington's statehood. The Washington Supreme Court held that state law applied and that all alluvion inured to the state. The case was appealed to the United States Supreme Court which held that federal law governs the ownership of accretion gradually deposited by the ocean on adjoining upland property conveyed by United States patent prior to statehood. Under federal law, the plaintiff had a right to the alluvion. The author notes that accretion or erosion had been commonly considered a problem of riparian or littoral rights. Under the rule of this case, however, where there is a federal patent issued before statehood is granted, the boundary is not a fixed unchanging line; it shifts with the movement of the mean high water mark. The rule set forth in Hughes seems to conflict with the line of cases holding that the sale of the state is to govern for lands bounded on streams or other waters. Prior to Hughes the question of rights to littoral alluvion had never been put squarely before the Supreme Court. (Heckerling-Fla)
W69-05785

VICTOR A HARDER REALTY AND CONSTRUCTION CO V CITY OF NEW YORK (DAMAGES CAUSED BY EXCAVATION AND GROUNDWATER REMOVAL).
64 NYS 2d 310-323 (Sup Ct 1946).

Descriptors: *New York, *Excavation, *Land subsidence, *Deformation, Damages, Pumps, Judicial decisions, Drainage engineering, Building codes, Soil compaction, Settlement (Structural), Retaining walls, Cost repayment, Cities, Local governments, Legislation, Groundwater, Movement, Buildings, Property values.
Identifiers: Strict liability, Absolute liability, Statutory liability, Restoration, Ordinances.

Plaintiff building owner sued defendant city for damages to his building as a result of excavations and drainage of ground water. Soil subsidence which resulted from defendant's activity caused lateral movement of plaintiff's building. The defendants claimed that their construction merely caused the plaintiff's structures, which were already leaning, to settle evenly. Evidence showed a lateral movement of other buildings in the vicinity. There was no finding of negligence on either defendants' part. The court held the city liable for the damage under a city ordinance. The ordinance provided that any party who caused excavations to extend more than 10 feet below curb level would be strictly liable for damages suffered by adjoining structures. This holding was in line with the court's finding that the excavations and removal of underground water, though done without negligence, were the responsible and proximate causes of the damage. The measure of damages was the diminution of the market value of the property, but, since as the restoration costs were less than the loss in market value, the plaintiff received only the cost of repairs actually necessitated by the defendants' acts. (Blunt-Fla)
W69-05786

AMERICAN POLICY OPTIONS IN THE DEVELOPMENT OF UNDERSEA MINERAL RESOURCES.
American Bar Association, Chicago, Ill. Section of Natural Resources Law.
Northcutt Ely.
Natural Resources Lawyer, Vol 1, No 1, pp 91-95, Jan 1968. 5 p.

Descriptors: *Continental shelf, *Continental slope, *Ownership of beds, *Exploitation, *Law of the sea, *Political aspects, Research and development, International commissions, Oceans, Competing uses, Adjudication procedure, Relative rights,

International waters, Water resources development, Federal government, Judicial decisions.
Identifiers: International conventions, Lateral boundaries, 200 meter isobath, Convention on Continental Shelf.

The article discusses two policy problems in the development of undersea mineral resources: (1) Limitation of a coastal nation's exclusive jurisdiction over the seabed. (2) Selection of a regime to govern exploration and exploitation of mineral resources lying beyond the defined limits of national jurisdiction. The definition of the Convention on the Continental Shelf which limits national jurisdiction to a depth of 200 meters, or beyond, to where the depth of the water admits of exploitation of mineral resources has two defects. The 200 meter isobath ignores the interests of coastal nations in their continental slopes beyond the continental shelf, and the exploitability test is ambiguous. He proposes that the exploitability test should be abandoned and a uniform lateral boundary of the state's seabed employed, perhaps in conjunction with the 200 meter isobath. As to the second problem no international agency is presently needed to administer exploitation of the deep seabed beyond national jurisdiction. Seabed resources should be open to exploitation and appropriation under the laws of the nation of the discovering expedition. Disputes between competing national interests may be resolved through accommodation and the development of adversary case law. (Storace-Fla)
W69-05787

CREATION OF WATER AND SEWAGE DISPOSAL AGENCIES.

N J Stat Ann secs 40:14B-2, 40:14B-34, 40:14B-35 to 40:14B-40, 40:14B-60 (1967).

Descriptors: *New Jersey, *Pollution abatement, *Sewage treatment, *Treatment facilities, Legislation, Water pollution control, Public health, Water purification, Local governments, Waste treatment, Impoundments, Administrative agencies, Condemnation, Eminent domain, Public utilities, Cost allocation.

The policy of this act is to provide an adequate water supply and to prevent pollution of state waters. To implement this policy, agencies of local governments are authorized to operate water works and sewage treatment facilities at the expense of the users of such services. These agencies may acquire property by condemnation. The act establishes the procedures for condemning property and compensating the former owner. The local government agencies are empowered to make reasonable regulations for operating a utility system. The discharge of sewage which may cause pollution is forbidden. (Childs-Fla)
W69-05788

LOGSDON V ANDERSON (SUIT TO ORDER REOPENING OF DIVERSION DITCH).
30 NW 2d 787-793 (Iowa 1948).

Descriptors: *Iowa, *Artificial watercourses, *Obstruction to flow, *Diversion structures, Water law, Judicial decisions, Watercourses (Legal), Flow, Ditches, Controlled drainage, Relative rights, Bypasses, Routing, Alteration of flow, Streamflow, Diversion, Overflow, Flood damage, Prescriptive rights, Natural streams, Legal aspects.
Identifiers: Injunctions (Mandatory).

Plaintiff, while tenant of land which defendant later acquired, opened a ditch to divert surface water. The ditch prevented water from flowing along an old stream bed traversing the tract. After plaintiff acquired the adjacent tract, the ditch became clogged; thereafter, rains caused overflow onto plaintiff's land. Plaintiff brought suit for injunctive relief, praying that the defendant be ordered to reopen the ditch and to compensate plaintiff for damages suffered. Defendant alleged that plaintiff's grantor shared prior clearing expenses. Since this was so, defendant contended that the court should order both parties to be responsible for maintenance of the ditch. The lower court ruled that there was no proof of any mutual agreement for maintenance; nevertheless, judgment was for the defendant due to the fact that the ditch became a natural watercourse through acquiescence. The appellate court reversed, holding that, although defendant may divert water, he is responsible for maintenance of the ditch in such a state as to prevent harm to his neighbors. The court held that an artificial watercourse can become natural through prescription, but only as to parties through whose lands it flows. Surrounding property owners are not prevented from complaining when the diversion ditch causes damage. The case was remanded for a determination of damages. (Wheeler-Fla)
W69-05789

KENNEBUNK, KENNEBUNKPORT AND WELLS WATER DIST V MAINE TURNPIKE AUTHORITY (DAMAGES FROM TURBIDITY OF BROOK).

71 A 2d 520-533 (Me 1950).

Descriptors: *Maine, *Riparian rights, *Turbidity, *Water supply, Damages, Relative rights, Reasonable use, Streams, Water law, Preferences (Water rights), Proprietary power, Judicial decisions, Road construction, Impaired water quality, Watersheds (Basins), Water sources, Administrative agencies, Damages.

Plaintiff, a water supplier, sued for damages for injury to its claimed property right to take water from a brook and to distribute the water to the public. Plaintiff alleged that defendant's construction of a turnpike across the brook and its watershed had made it so turbid as to render the water from it unfit for distribution. The lower court rejected the referee's finding for plaintiff. The appellate court remanded to determine whether plaintiff had riparian right to take the water. The court noted that plaintiff's claim in the lower court had been based upon its right as a quasi municipal corporation under a legislative charter to distribute water from the brook. A determination of whether plaintiff's ownership of land gave it the right to use the brook as a source of supply for public distribution must be made. The court also remanded for determination whether defendant's use of the land, as upper riparian owner, was for reasonable purposes. This question depends not only on the use of upper owner, but also upon use being made by lower owner. The court dismissed plaintiff's contention regarding nuisance since there were no special damages to plaintiff. (Wheeler-Fla)
W69-05790

THE CONVENTION ON FISHING AND LIVING RESOURCES OF THE HIGH SEAS.
James A. Crutchfield.
Nat Resources Lawyer, Vol 1, No 2, pp 114-124, June 1968. 11 p, 7 ref.

Descriptors: *International law, *Marine fisheries, *Fish management, Fish conservation, Fish reproduction, Fishing gear, Law of the sea, International waters, Oceans, Oceanography, Marine fish, Legal aspects, Water law, Conservation, Resource allocation.
Identifiers: *Coastal states.

The wording of the Convention on Fishing and Living Resources suggests that there are no effective restraints on the extension of the power of the coastal state over living resources of the sea. The objectives of the Convention are not clearly defined. 'Optimal' use is the broad theme of the undertaking, however, this theme fails to recognize the inevitable tendency toward overcapacity and inefficiency in a common property resource. No guide to the treatment of new entrants is offered. The Convention has articulated the problem of fishery conservation primarily in terms of scientific benefits and detriments. It should be noted that, of the coastal states, the smallest states have led the fight for special privileges. The convention allows for permissive multilateral agreements covering exploitation of living resources, but the lack of a concrete objective detracts from any incentive for such agreements. The author suggests establishing a system of national marine lakes. The Convention offered no effective means of limiting future pressure on marine fisheries. Only procedures for alleviating current problems were suggested; no governing principles were laid down. The author suggests guidelines which would restrict entry and promote the economic efficiency of future marine fisheries. (Holt-Fla)
W69-05791

HARBISON-WALKER REFRACTORIES CO V SMITH (FLOOD DAMAGE DUE TO CLOGGED CULVERT).

194 F 2d 530-531 (6th Cir 1952).

Descriptors: *Kentucky, *Flood damage, *Rainfall, *Culverts, Damages, Excessive precipitation, Overflow, Floods, Runoff, Judicial decisions, Legal aspects, Obstruction to flow.
Identifiers: Negligence, Debris.

This action was brought to recover for injuries to plaintiff's property when a clogged culvert on defendant's land caused flooding. The court in a per curiam opinion, held that where there was floatable debris on defendant's property and in the vicinity, it might reasonably have been foreseen that rainfall might cause fresh debris to clog the culvert resulting in an overflow onto plaintiff's property. Failure of defendant to remedy such situation was negligence creating liability to plaintiff. (Heckerling-Fla)
W69-05792

ADAMS V GREENWICH WATER CO (DIVERSION OF RIVER FOR PUBLIC WATER SUPPLY).

138 Conn 205, 83 A 2d 177-184 (1951).

Descriptors: *Connecticut, *Diversion, *Public benefits, *Water supply, Eminent domain, Judicial decisions, Cities, Local governments, Relative rights, Riparian land, Riparian rights, Alteration of flow, Rivers, Public rights, Social needs, Community development, Interstate rivers, Natural flow, Appropriation, Islands, Legal aspects.
Identifiers: Injunctions (Prohibitory).

Plaintiffs owned land along a certain river. Some of the plaintiffs had created artificial ponds and islands in the river. They all used the river for swimming, fishing, and skating and drew water from it for their lawns, gardens, and livestock. Defendant had a franchise to furnish water for public and domestic use. It purchased its water from a nearby city. During a period of extreme drought in the summer of 1949, the defendant began pumping water from the river. At no time did the pumping cut off the flow of the river completely, however, at the height of the drought the defendant was diverting more than half the flow. The water was not 'taken' by eminent domain proceedings. Plaintiffs brought this suit to enjoin defendant from diverting the river except as permitted by agreement. The court denied injunctive relief, holding that it is well within the court's discretion to deny an injunction against the infringement of riparian rights if to grant such relief would adversely affect the public interest. (Heckerling-Fla)
W69-05793

WHITE V PENNSYLVANIA RR (DAMAGES FOR OBSTRUCTION OF STREAM).

354 Pa 397, 47 A 2d 200-204 (1946).

Descriptors: *Pennsylvania, *Railroads, *Obstruction to flow, *Landfills, Alteration of flow, Judicial decisions, Damages, Floods, Flood damage, Riparian land, Riparian rights, Culverts, Diversion, Natural flow doctrine, Stream flow, Ditches, Natural streams, Legal aspects, Diversion structures.

Plaintiff owned about 40 acres of fertile muckland situated in a valley. About 100 years ago, defendant's predecessor in title built an elevated embankment, as a roadbed for its tracks, immediately to the west of, and extending the entire length of, the mucklands. The embankment was constructed in the channel of a creek which flowed naturally along the valley. At the same time, defendant's predecessor in title diverted the creek into a substituted channel and constructed a culvert under its tracks to afford a nearby run an outlet into the creek. Until about 15 years prior to initiation of this suit, defendant and its predecessor maintained the creek in good condition. Since then, defendant failed to keep the creek reasonably free from obstructions. This condition caused the waters of the creek to be forced onto parts of the muckland, rendering such land untillable. The court held that if a new watercourse is made, different from that which nature has provided, and the discharge is thereby made to fall upon a different place and in a different manner, causing damage to the owner of the servient tenement, the owner of the superior or dominant tenement is liable. (Heckerling-Fla)
W69-05794

BILLERIO V FOTI (FLOOD DAMAGE DUE TO DAMMING OF STREAM).
97 NYS 2d 860-861 (S Ct 1950).

Descriptors: *New York, *Natural streams, *Damages, *Obstruction to flow, Dams, Streams, Riparian rights, Flood damage, Riddance (Legal aspects), Conservation, Overflow, Surface runoff, Natural flow, Streamflow, Relative rights, Judicial decisions, Ditches, Repulsion (Legal aspects).
Identifiers: Injunctions (Mandatory).

Plaintiffs brought suit to avoid a nuisance which plaintiffs claim was caused by defendants and to recover damages for flooding. The plaintiffs purchased the property by deed. Defendants' premises adjoined the property. After plaintiffs took possession, they decided to develop a new vineyard on a portion of their land which had previously been devoted to other farming purposes. Plaintiffs, on the advice of conservation experts, took certain steps to rid the area of excessive moisture and dampness. These steps included the digging of a new ditch and the removal of brush from existing ditches and from what they claimed was the body of a stream. Defendants claim that no such stream existed and that excess water came onto their property due to the ditching. The defendants dammed up the stream to exclude the flow from their property. The court found that the water coming onto the plaintiff's property was in the bed of or part of a well-defined stream that previously existed and that the flow was such as to constitute no extra burden on defendants' tract. Damages were awarded to plaintiffs, and a mandatory injunction commanding removal of the dam was issued. (Heckerling-Fla)
W69-05795

SMITH V UNITED STATES (DAMAGES FOR FILLING OF RESERVOIR).

113 F Supp 131-136 (D Del 1953).

Descriptors: *Delaware, *Stream erosion, *Federal government, Judicial decisions, Running waters, Natural streams, Sedimentation, Riparian rights, Construction, Reservoirs, Sediments, Water pollution effects, Water pollution sources, Sands, Gravels, Banks, Dams, Erosion.
Identifiers: Federal Tort Claims Act, Demurrers, Upstream owner.

Plaintiff leased a three-acre tract of land, the northerly boundary of which was a free running stream. The stream ran through defendant's air base which was located up stream from plaintiff's land. Prior to the construction of the air base, plaintiff maintained his dwelling house, a store and apartment building on his property. Five ponds, fed from the creek water collected behind a dam he had built across the creek, were also located on the land. Plaintiff alleged that defendant, in constructing the base, had changed the grade and contour of the upstream land so as to increase the drainage of surface waters. This increased flow washed sand and gravel downstream, eventually filling plaintiff's reservoir. The bed of the creek was raised so that only a trickle of water ran through plaintiff's land. Plaintiff sought damages measured by loss of profits in his business, the value of destroyed fish and aquatic plants, the deprivation of the normal flow of water, and the expense incurred in removal of his home and business to other land. The suit was brought under the Federal Tort Claims Act. Defendant moved to dismiss the complaint for failure to state a cause of action. The court held that under Delaware law the complaint stated a cause of action. (Heckerling-Fla)
W69-05796

ANNIN V STATE (DAMAGE CAUSED BY FILLING OF CHANNEL).

206 Misc 24, 132 NYS 2d 471-475 (Ct Cl 1954).

Descriptors: *New York, *Landfills, *Riparian rights, *Channel flow, Channel improvements, Channels, Open channel flow, Flumes, Overflow, Damages, Judicial decisions, Construction, Streams, Obstruction to flow, Diversion, State governments, Relative rights, Fish hatcheries, Cost repayment.
Identifiers: Proximate cause.

Plaintiff and the State owned and operated adjoining fish hatcheries on a creek which flowed past plaintiff's property. Before certain construction work by the state, the stream divided naturally into two channels at the state's property, creating an island on which the main buildings of the state hatchery were located. The state, in order to increase the capacity of its hatchery, filled in the east channel and constructed a new flume in the west channel. It was plaintiff's contention that the filling of the east channel raised the level in the creek as it flowed past his property, thereby impairing the operation of his facilities and rendering necessary certain structural changes for which he sought compensation. The court held that the state may not fill existing channels in such a way as to hold back waters and thereby overflow or damage the property of an adjacent riparian owner; however, to impose liability, it must appear that the damage complained of is the proximate result of the act of the state in obstructing the channel. The evidence presented failed to establish this fact. (Heckerling-Fla)
W69-05797

ALLEN V STATE (FLOOD DAMAGE DUE TO CONSTRUCTION OF DIKE).

208 Misc 385, 143 NYS 2d 867-873 (Ct Cl 1955).

Descriptors: *New York, *Dikes, *Flood control, *State governments, Flood damage, Judicial decisions, Community development, Federal government, Riparian rights, Rivers, Riparian land, River regulation, Engineering structures, Flood protection, Currents (Water), Erosion, Floods, Cities, Relative rights, Backwater.

Plaintiffs sued for damages caused by a defective flood control plan. Plaintiffs' land was bounded by a river. In connection with a federal flood control project, a dike along the river was rebuilt. In addition, a cross dike was constructed to prevent water from backing into the town of South Corning. Corning had improved flood protection. Becuase of the new structures, plaintiffs' land, in time of flood, was exposed to the river current, and the cross dike tended to impound the back water and increase its depth. The result was a washing away of plaintiffs' land, flooding of their cellars, and damage to certain buildings and personal property. The question was whether claimants had stated any cause of action against the state. The court held that a riparian owner may not construct a dike if such dike, in times of ordinary floods, will cause waters to damage lands of another. Judgment was entered for plaintiff. (Heckerling-Fla)
W69-05798

MONTELEONE V BOH BROS CONSTRUCTION CO (LIABILITY FOR DAMAGE CAUSED BY PILE DRIVER VIBRATIONS).
217 So 2d 754-757 (4th CCA La 1969).

Descriptors: *Vibrations, *Subsidence, *Marinas, *Louisiana, Judicial decisions, Land subsidence, Compaction, Pile driving, Foundation failure, Foundations, Flexible foundations, Pile foundations, Construction, Damages, Water table.

Plaintiff sought $24,749 for damage caused during construction of defendant's marina. The construction entailed use of pile drivers which caused vibrations allegedly damaging plaintiff's house. Defendant contended that plaintiff's damages were due to natural soil subsidence accelerated by the lowering of the water table by subsurface drainage works previously installed and to the overall unsuitability of the house foundations for use on the type of land involved. This court amended and affirmed a verdict for the plaintiff. The court found it impossible to determine with any degree of certainty that portion of the damages attributable to soil subsidence and that portion traceable to acceleration of subsidence due to the construction. Where there are at least two concurrent causes which contributed to plaintiff's injury and defendant was responsible for only one of the causes, damages should be assessed against the defendant in an amount equal to 1/2 the total damage figure. (Blunt-Fla)
W69-05799

ANDERSON V CITY OF JEFFERSON (SUIT FOR DAMAGES RESULTING FROM DISCHARGE OF WATERS UPON PRIVATE PROPERTY).
262 SW 2d 169-172 (Ct App Mo 1953).

Descriptors: *Kansas, *Watercourses (Legal), *Drainage water, *Surface waters, Judicial decisions, Legal aspects, Natural streams, Cities, Banks, Channels, Beds, Ditches, Surface runoff, Repulsion (Legal aspects), Watersheds.

Plaintiff brought action against defendant city for damages resulting from discharge of surface waters onto plaintiff's property and to enjoin defendant from constructing an additional drain into a ditch running across plaintiff's property. The court discussed two issues: (1) Whether the ditch on plaintiff's property was a 'watercourse'; (2) Whether the common enemy doctrine prohibited defendant's actions. First, the court defined 'watercourse' as a living stream of water which has well defined banks, a channel and a bed; it is fed from more permanent sources than mere surface water. The court found that the ditch was not a watercourse. As to the second issue, while the court found that surface water is a common enemy which owner of a dominant tenement may direct upon a servient tenement, the dominant owner may not artificially impound or collect surface water and cast it in increased and destructive quantities upon the servient estate. The court granted the relief sought by the plaintiff. (Logan-Fla)
W69-05800

GOVERNMENT AND WATER RESOURCES DEVELOPMENT,
Colorado State Univ., Fort Collins. Dept. of Economics.
For primary bibliographic entry see Field 06D.

W69-05878

WATER RIGHTS AND LEGISLATION IN THE EASTERN STATES,
Economic Research Service, Washington, D. C. Resource Development Economics Div.
Harold H. Ellis.
For main entry see Field 06B, W69-05737. Water Resources and Econ. Develop. in the South, North Carolina Univ., API, Series 16, pp 109-133, Aug 1965 - 25 p, 72 ref.

Descriptors: *Water rights, *Legislation, Natural streams, Surface runoff, Groundwater, Underground streams.

Water supplies are classified by the courts and rights to use them vary according to their particular designation. Some common classifications of natural water supplies include natural water courses, diffused surface water, percolating ground water, and underground streams. Water rights rules with respect to each of the classifications are discussed. Legislative developments are explored. Nineteen future issues of water rights are summarized. Numerous references to specific laws and cases are cited. (Grossman-Rutgers)
W69-05879

CITY OF MERIDIAN V TINGLE (RECOVERY OF DAMAGES AGAINST MUNICIPALITY FOR CREEK POLLUTION).
For primary bibliographic entry see Field 05G.
W69-05955

BEALS V ROBERTSON (MINE WATER RUNOFF).
For primary bibliographic entry see Field 05G.
W69-05956

ALLEY V FICKEL (DIVERSION OF WATER BY LEVEE).
For primary bibliographic entry see Field 04A.
W69-05957

KAY-NOOJIN DEV CO V KINZER (SURFACE WATERS AND THE NATURAL FLOW DOCTRINE).
For primary bibliographic entry see Field 04A.
W69-05958

PANAMA CITY V YORK (SURFACE WATERS AND THEIR NATURAL FLOW).
For primary bibliographic entry see Field 04A.
W69-05959

ADAMS V LAWLER (SURFACE WATERS AND THE NATURAL FLOW DOCTRINE).
For primary bibliographic entry see Field 04A.
W69-05960

NEWTON COCA COLA BOTTLING CO V MURPHREY (DIVERSION OF SURFACE WATERS).
For primary bibliographic entry see Field 04A.
W69-05961

YONADI V HOMESTEAD COUNTRY HOMES (SURFACE WATERS AND THE NATURAL FLOW DOCTRINE).
For primary bibliographic entry see Field 04A.
W69-05962

MISKOTTEN V DRENTEN (ARTIFICIAL DRAINAGE OF SURFACE WATERS).
For primary bibliographic entry see Field 04A.
W69-05963

UNITED STATES V 11.48 ACRES OF LAND, ETC (COMPENSATION FOR CONDEMNED RIPARIAN RIGHTS).
For primary bibliographic entry see Field 06C.
W69-05964

STATE V AMERICAN ALKYD INDUSTRIES (PENAL LIABILITY FOR WATER POLLUTION STRICTLY CONSTRUED).
For primary bibliographic entry see Field 05G.
W69-05965

UPPER GREENWOOD LAKE PROPERTY OWNERS ASS'N V GROZING (CONTROLLED USE OF LAKE WATERS).
For primary bibliographic entry see Field 04A.
W69-05966

VINSON V TURNER (INJUNCTION AGAINST CONCENTRATION OF SURFACE WATER RIDDANCE).
For primary bibliographic entry see Field 04A.
W69-05967

ATCHISON T AND S F RY V TAYLOR (FLOOD DAMAGE DUE TO RAILWAY EMBANKMENT).
For primary bibliographic entry see Field 04A.
W69-05968

KECK V HAFLEY (DIVERSION OF STREAM FLOW).
For primary bibliographic entry see Field 04A.
W69-05969

COMMONWEALTH V KELLEY (NEGLIGENT OBSTRUCTION TO FLOW).
For primary bibliographic entry see Field 04A.
W69-05970

MOWREY V COLEMAN (QUESTIONED VALIDITY OF WATER DISTRICT).
277 SW 2d 481-482 (Ark 1955).

Descriptors: *Arkansas, *Assessments, *Water districts, *Evaluation, Public benefits, Estimated benefits, Legislation, Judicial decisions, Legal aspects, Financing, Remedies, Relative rights.
Identifiers: *Res judicata, Affirmative defenses.

Property owners brought suit attacking an entire assessment of benefits in a suburban water improvement district. Plaintiffs asserted that the assessed benefits were so excessive that a reassessment should be ordered. Defendants, who were commissioners of the district, admitted that the assessed benefits were in fact excessive and proposed that a decree be entered by which the assessment would be set aside and a new assessment ordered. Plaintiffs filed objections to the decree and questioned the validity of the district itself. The chancellor over-ruled the objections and entered the decree. Plaintiffs appealed. The court held that plaintiffs' attack upon the district came too late. The suburban improvement district law provides that an appeal from the order creating the district must be taken within thirty days; if an appeal is not so taken, the judgment shall be conclusive. Plaintiffs' charge (that the water improvement district was illegally organized) was made over two years after the order creating the district was filed; the issue had become res judicata. Therefore, the chancellor's ruling was affirmed. (Reed-Fla)
W69-05971

INJURING HIGHWAY BOUNDARY, PIER, SEAWALL, DOCK, ROCK, BUOY, LANDMARK, MILE-BOARD, PIPE, MAIN, SEWER, MACHINE, TELEGRAPH, OR OTHER PROPERTY.

N Y Penal Law secs 1423.2, 1423.3, 1423.8, 1423.12 (McKinney 1968).

Descriptors: *New York, *Damages, *Dams, *Docks, Piers, Quays, Jetties, Gates, Piles (Foundations), Coastal structures, Sea-walls, Shore protection, Locks, Rivers, Pipes, Drains, Sewers, Banks, Bank protection, Buoys, Legislation, Highways, Bridges, Public lands.
Identifiers: Boom, Main, Beacons, Penalty (Criminal).

Anyone who wilfully or maliciously displaces, removes, injures, or destroys: a bridge; or, a pier, boom, or dam lawfully erected or maintained on any water of the state or places any gate in or about such dam; or, a pile, or other material, in the ground which is used for securing any sea-bank or sea-walls or the bank or dam of any river, or any dock, quay, jetty, or lock; or, a sewer plant, sewer or drain, or a pipe or main connected with or forming part of a sewer or drain, is punishable by imprisonment for not more than two years. A person who, wilfully or maliciously removes or destroys a buoy or beacon, lawfully placed on any water within the state, is punishable by imprisonment for not more than two years. (Shevin-Fla)
W69-05972

FINDLEY LAKE PROPERTY OWNERS, INC V TOWN OF MINA (MAINTENANCE AND CONTROL OF WATER LEVEL OF LAKE).
For primary bibliographic entry see Field 04A.
W69-05973

THE GENEVA CONVENTIONS ON THE LAW OF THE SEA: SOME SUGGESTIONS FOR THEIR REVISION,
American Bar Association, Chicago, Ill. Section of Mineral and Natural Resources Law.
Shigeru Oda.
Natural Resources Lawyer, Vol 1, No 2, pp 103-113, June 1968. 11 p.

Descriptors: *International law, *Water resources, *Continental shelf, Oceans, Mineralogy, Shellfishing, Commercial fishing, Legal aspects, Publications, Conferences, Surveys, Water law, Law of the sea, Governments, Legislation, Treaties.
Identifiers: Geneva Conventions, Territorial sea, Contiguous zone, Superadjacent waters, Fishery zone.

Various suggestions are made regarding the law of the sea. First, the concept of 'continental shelf resources' as embodied in the Convention on the continental shelf should be specifically limited to include only mineral resources. Second, any recommendations on a new regime of deep sea mining should derive from an understanding that, since the Convention already covers the deep sea, the relevant provisions on the outer limit of the shelf should be amended. Third, the superadjacent waters of the continental shelf should be given the status of a contiguous zone. Fourth, the provision concerning the contiguous zones should be redrafted so as to enable the coastal states to exercise control over foreign vessels in the contiguous zones which encroach upon the interests of the coastal state. The protection of such interests was, after all, a compelling reason for establishing contiguous zones. Fifth, the 12-mile fishery zone should be universally adopted lest the coastal states continue to extend unilaterally their fishery jurisdiction. (Childs-Fla)
W69-05974

DI GIACINTO V NEW JERSEY ZINC COMPANY (DIVERSION OF SUBTERRANEAN WATERCOURSE).
For primary bibliographic entry see Field 04B.
W69-05975

SHELLFISH.

N J Stat Ann secs 50:1-1 to 50:1-4, 50:1-37, 50:1-38 (1967).

Descriptors: *Legislation, *New Jersey, *Leases, *Shellfish, Oysters, Mollusks, Permits, State governments, Legal aspects, Administrative agencies, Submerged lands, Beds under water, Tidal waters, Exploitation, Regulation, Fish management.
Identifiers: Penalties (Criminal).

The state has the power to control the distribution and removal of shellfish from underwater lands leased from the state. The lessee may be required to post bond to insure faithful observance of the promulgated regulations. The planting of oysters, seed oysters, or mollusks native to a foreign country may be commenced only after permission has been obtained from the state. Failure to obtain such permission subjects one to a fine of one thousand dollars, revocation of his license, and cancellation of his lease. Permission is not required for the planting of oysters, seed oysters, or mollusks, commonly known as American or Eastern oysters. Nothing in this statute affects the catching of floating fish in tidal waters. (Logan-Fla)
W69-05976

COATES V UNITED STATES (DIKES AS THE PROXIMATE CAUSE OF FLOODING).
For primary bibliographic entry see Field 04A.
W69-05978

BOROUGH OF AUSTIN V A AND P CORRUGATED BOX CORPORATION (FLOODING BELOW A DAM).
For primary bibliographic entry see Field 04A.
W69-05979

CLARK V TODD (INVALIDATION OF OYSTER DREDGING LICENSES).

64 A 2d 547-549 (Md 1949).

Descriptors: *Maryland, *Tidal waters, *Oysters, *Dredging, Commercial fishing, Boats, Fisheries, Statutes, Legislation, Tributaries, Permits, Administrative agencies, Legislation, Fish conservation, Rivers, Regulation.
Identifiers: Injunctions (Mandatory), Injunctions (Prohibitory).

The Fisheries Commission brought action to invalidate oyster dredging licenses and to restrain defendants from dredging oysters. From decrees sustaining demurrers and dismissing the bills, the commission appealed. The main issue on appeal was whether violations of the state statute which restricted the size of boats for dredging oysters in tidewaters could be attacked by way of injunction. The court pointed out that rivers affected by the ebb and flow of the tide are public rivers or arms of the sea and that the land under such tidewaters became vested in the state by charter. It is well established that oysters, like fish and game generally, are originally the property of the state, and no individual has any property rights in them, other than such as the state may permit him to acquire. Even when oysters are taken and reduced to possession by an individual, his rights of ownership may be regulated and altered by appropriate legislation. The court held that, since the right of dredging in these tidewaters is a valuable natural resource, the state has authority, by virtue of its police powers, to inact protective legislation regulating such rights. The court reversed and remanded for further proceedings. (Reed-Fla)
W69-05980

UNITED STATES V 1,096.84 ACRES IN MARION COUNTY (AUTHORIZATION OF FEDERAL DAMS AND RESERVOIRS).

99 F Supp 544-548 (W D Ark 1951).

Descriptors: *Compensation, *Arkansas, *Eminent domain, *Federal project policy, Condemnation, Federal Government, Dams, Reservoirs, Judical decisions, Legal aspects, Remedies, Flood control, Flooding, Public benefits, Public rights.

Defendant objected to the taking of that portion of her land within a reservoir area, but which lay above the maximum elevation subject to innundation. The Secretary of the Army had selected the land under his authority to acquire lands necessary for a dam and reservoir project for flood control. The court found for the defendant, holding that condemnation of land for the purpose of building a dam and reservoir was condemnation for a 'public use' and therefore, was not subject to judicial review. (Gabrielson-Fla)
W69-05981

CRARY V STATE HIGHWAY COMM'N (EMINENT DOMAIN).
68 So 2d 468-472 (Miss 1953).

Descriptors: *Mississippi, *Eminent domain, *Public land, *Navigable waters, Bridges, Shores, Oysters, Navigation, State governments, Riparian rights, Compensation, Ownership of beds, Riparian land, Permits, Legislation, Water law, Judicial decisions, Legal aspects, Condemnation, Low water mark, Public rights, Public benefits.
Identifiers: Revocable license.

Plaintiffs were riparian owners of property on navigable waters. A state statute gave riparian owners so situated the sole right to plant and gather oysters and to erect bath houses in front of their lands up to 500 yards from the average low water mark. Defendant state constructed a bridge across part of the waters extending 500 yards in front of plaintiff's property. Plaintiffs asserted that, by erecting the bridge, the state had taken their property for public use and that they were entitled to compensation. The court held that navigable waters, and the beds thereof, were owned by the state as trustee for the people of the state. The statute granting the right to raise oysters and to build bath houses merely gave a revocable license, a privilege, to do so. The privilege was subject to the superior right of the state to subject land already set aside for public pruposes to an addition servitude for the public benefit. This being so, plaintiff had no property right which could be the subject of state appropriation and, therefore, was not entitled to compensation. (Helwig-Fla)
W69-05982

STATE V LEMAR (TITLE TO TIDAL BEDS).

87 A 2d 886-888 (Me 1952).

Descriptors: *Permits, *Maine, *Navigable waters, *Ownership of beds, Cities, Beds under water, River beds, Beds, Water law, Legal aspects, Judicial decisions, Legislation, Local governments, State governments, Shores, Bloodworms, Tidal waters, Claims, Regulation.
Identifiers: *Constitutional law.

Defendant was convicted of digging bloodworms within city limits without a license. His action was in violation of a municipal ordinance requiring a license to engage in such activity and providing that no license may be granted to a person who is not a resident of the town. Defendant was a non-resident of the town. Defendant attacked the statute on constitutional grounds. The court held that unless the state has parted with title, it owns the bed of all tidal waters within its jurisdiction and has power to regulate fishing therein. The state legislature has the power to delegate to the municipality this power of regulation. It is not unreasonable or arbitrary for a municipality to give preference to town residents over non-residents in digging bloodworms. (Helwig-Fla)
W69-05983

UNITED STATES V 2973 ACRES OF LAND (CONDEMNATION OF FLOWAGE EASEMENTS).

218 F 2d 524-526 (4th Cir 1955).

Descriptors: *Virginia, *Eminent domain, *Easements, *Condemnation value, Condemnation, Property values, Evaluation, Compensation, Federal government, Legal aspects, Electric power, Electric power industry, Flood control, Projects, Multiple-purpose projects, Flooding, Damages, Judicial decisions, Legal aspects.
Identifiers: Servitudes, Flowage easements.

A power company held flowage easements over certain land. The government filed condemnation proceedings with respect to this land, intending to use the tract as part of a flood control project. The land owner conveyed her interest to the government for one dollar. The trial court held the power company was entitled to recover the fee simple value of the land. The government appealed, contending: (1) That there can be no recovery against the government for rights which have value only because of the development of power on a navigable stream, and (2) That the government is liable only for a sum equal the decrease in value of the land where the servitude to be extinguished. The appellate court overruled the government's first contention. As to the second question, the court held that the value of the flowage rights was equal to the difference between the value of the land with the servitude as compared with the value without the servitude. Since the flowage rights of the power company rendered the land valueless to the fee owner, the company was entitled to the fee simple value of the land without the easement. (Helwig-Fla)
W69-05984

GOWING V LEHMANN (WATER USE EASEMENT).

101 A 2d 463-466 (NH 1953).

Descriptors: *New Hampshire, *Easements, *Water supply, *Pumps, Judicial decisions, Water sources, Artesian wells, Developed waters, Distribution systems, Pipelines, Relative rights.
Identifiers: Covenants, Equitable servitudes.

Plaintiff and defendant purchased adjoining land from a common grantor. An artesian well situated on defendant's land supplied water to a pipeline serving buildings on plaintiff's land as well as defendant's land. Plaintiff's deed specifically granted an easement to take water from the well and made additional provision for a right of entry to repair the pipeline. No mention was made of the pump. Subsequently, defendant developed a new source of water supply which by-passed the lines supplying the plaintiff's property. Plaintiff sought to require defendant to continue operation of the pump. The court held that defendant was under no duty to continue pump operation. The easement did not extend to the right to use the pump, and the discontinuance of pump operation was not an interference with plaintiff's rights under the easement. (Molica-Fla)
W69-05985

ELLER V BOARD OF EDUCATION OF BUNCOMBE COUNTY (WATER POLLUTION AS CONSTITUTING A 'TAKING' OF PROPERTY).
For primary bibliographic entry see Field 05G.
W69-05986

AVERY V BEALE (CONSTITUTIONALITY OF RIPARIAN PRIORITY TO ERECT DUCK BLINDS).

195 Va 690, 80 SE 2d 584-593 (1954).

Descriptors: *Virginia, *Riparian rights, *Legislation, *Public rights, Legal aspects, Migratory birds, Waterfowl, Wildlife conservation, State governments, Judicial decisions, Hunting, Permits, Rela-

tive rights, Navigable waters, Non-navigable waters, Public benefits, Riparian land, Riparian waters.
Identifiers: *Duck blinds, *Constitutionality, Class legislation, Injunctions (Prohibitory), Injunctions (Mandatory).

A Virginia statute gave riparian owners the prior and exclusive right to erect shooting blinds in public waters adjoining their property after compliance with certain licensing requirements. Failure to elect this privilege opened the area to whoever acquired a license. A riparian brought action to enjoin the use of a duck blind constructed by non-riparian within the prohibited 500 yard range of the riparian's blinds. The non-riparian filed a cross bill for an injunction and for damages for infringement of his right to use his blind. The circuit court enjoined maintenance of the blind by the non-riparian for the entire hunting season. On appeal by the non-riparian, the supreme court of appeals held that the state may license and regulate duck blinds under its power over public waters. In classifying licensees, however, there must exist a reasonable basis for the class definition selected. The classification scheme is presumed to be reasonable. The duck blind statutes are designed to provide riparian sanctuaries for migratory fowl, to protect hunters, and to create better sport and recreational facilities. The privilege conferred on the riparian owners as a class is not absolute; the privilege is a conditional one and is based on prior rights of riparians. Such a classification offends neither the federal nor state constitution. (Harris-Fla)
W69-05987

MOLTION V STATE (FLOODING ABOVE A DAM).
For primary bibliographic entry see Field 04A.
W69-05988

BLACK V STATE (FLOODING OF LAND BY THE STATE).
For primary bibliographic entry see Field 04A.
W69-05989

HANCOCK V STULL (OBSTRUCTION TO NATURAL FLOW OF SURFACE WATER).
For primary bibliographic entry see Field 04A.
W69-05990

HUIE V CITY OF NEW YORK (CITY'S OBLIGATION TO MAINTAIN SUBSTITUTE HIGHWAYS).

285 App Div 922, 137 N Y S 2d 605-606 (Sup Ct 1955).

Descriptors: *New York, *Reservoir construction, *Water supply, *Highway icing, Highways, Ice, Sleet, Road construction, Snow, Snow removal, Judicial decisions, Legal aspects, Cities, Local governments, Legislation, Operation and maintenance.

The City of New York had constructed a large water supply reservoir in Delaware County and had approved the constuction of substitute highways. The statute authorizing the highways directed the city to construct, repair, and forever maintain such additional highways. After the construction of the highways, a dispute arose between the city and two nearby towns concerning the duty of the city to maintain the highways free from snow and ice. The Supreme Court is authorized to correct, at any time, any defect in any pleading or proceeding brought in connection with the construction of the water supply reservoir. The court found no defect in the orders setting forth the city's duties in regard to the highways. The motion by the towns to amend the prior order was not the proper procedure to follow in this situation. (Shevin-Fla)
W69-05991

INDIAN GRAVE DRAINAGE DIST V CONDRON (SUIT TO ESTABLISH RIGHTS OF PERSON OUTSIDE DRAINAGE DISTRICT).
For primary bibliographic entry see Field 04A.
W69-05993

GROBART V NORTH JERSEY DIST WATER SUPPLY COMMISSION (DIVERSION OF FLOW).
For primary bibliographic entry see Field 04A.
W69-05994

JENNINGS V LEAGUE OF CIVIC ORGANIZATIONS (BREACH OF CONTRACT TO PRODUCE WATER).
For primary bibliographic entry see Field 04A.
W69-05995

GEORGIA POWER CO V DREESE (NEGLIGENT WATER DISCHARGE).
For primary bibliographic entry see Field 04A.
W69-05996

LEVIN V MYERS (DISCHARGE OF SURFACE WATERS).
For primary bibliographic entry see Field 04A.
W69-05997

LOCH SHELDRAKE ASSOCIATES, INC V EVANS (RESERVATION OF REASONABLE USE).
For primary bibliographic entry see Field 04A.
W69-05998

HALSRUD V BRODALE (PRIVATE DRAINAGE EASEMENT AGREEMENTS).
For primary bibliographic entry see Field 04A.
W69-05999

STATE V BROWNS, INC (OBSTRUCTION OF DRAINAGE EASEMENTS).
For primary bibliographic entry see Field 04A.
W69-06000

6F. Nonstructural Alternatives

FLOOD PLAIN INFORMATION, CONLEY CREEK-SOUTH RIVER, METROPOLITAN ATLANTA, GEORGIA.
Corps of Engineers, Savannah, Ga.
For primary bibliographic entry see Field 04A.
W69-05913

FLOOD PLAIN INFORMATION, CASEY CANAL SOUTH, SAVANNAH AND CHATHAM COUNTY, GEORGIA.
Corps of Engineers, Savannah, Ga.
For primary bibliographic entry see Field 04A.
W69-05914

A FRAMEWORK FOR THE MULTIPLE USE OF MUNICIPAL WATER SUPPLY AREAS,
Cornell Univ., Ithaca, N. Y.
For primary bibliographic entry see Field 06D.
W69-05935

6G. Ecologic Impact of Water Development

THE STRATEGY OF BUILDING MODELS OF COMPLEX ECOLOGICAL SYSTEMS,
Canadian Dept. of Forestry, Victoria (British Columbia).
For primary bibliographic entry see Field 06A.
W69-05713

THE ANALYSIS OF DETERMINATION IN POPULATION SYSTEMS,
Forest Service (USDA), New Haven, Conn. Northeastern Forest Experiment Station.
For primary bibliographic entry see Field 06A.
W69-05714

07. RESOURCES DATA

7A. Network Design

DETERMINING MAXIMUM RELIABILITY AND EFFICIENCY OF HYDROMETEOROLOGICAL SYSTEMS AND INSTRUMENTS,
State Hydrological Inst., Leningrad (USSR).
A. M. Dimaksyan, and V. P. Petrov.
Trans from Trudy Gos Gidrol Inst, No 149, 1967, pp 114-132. Soviet Hydrol, Selec Pap, No 6, pp 569-584, 1967. 16 p, 8 fig, 4 ref.

Descriptors: *Network design, *Reliability, *Probability, Hydrologic data, Meteorological data, Data collections, Specifications, Standards, Optimization, Economics, Efficiencies, Design criteria, Networks, Evaluation, Systems analysis.
Identifiers: Hydrometeorological networks.

Methods are given for determining the reliability of hydrometeorological data instruments and networks. Optimum network reliabilities for which the overall costs of development and operation are minimum, may be calculated by simple formulas using graphical methods for obtaining results quickly. Several examples of solutions of network reliability optimization problems are given. (Knapp-USGS)
W69-05658

POTOMAC RIVER WATER QUALITY NETWORK, 1968 WATER YEAR.
Interstate Commission on the Potomac River Basin, Washington, D. C.
For primary bibliographic entry see Field 05B.
W69-05920

ACCURACY IN DETERMINING THE MEAN PRECIPITATION DEPTH OVER AN AREA,
Main Geophysical Observatory, Leningrad (USSR).
For primary bibliographic entry see Field 02B.
W69-05948

THE ECONOMIC APPROACH TO THE PLANNING OF A NETWORK OF METEOROLOGICAL STATIONS,
Main Geophysical Observatory, Leningrad (USSR).
L. S. Gandin, and R. L. Kagan.
Trans from Trudy GGO, No 208, 1967, pp 120-131. Soviet Hydrol, Selec Pap, No 6, pp 597-606, 1967. 10 p, 3 fig, 2 tab, 7 ref.

Descriptors: *Network design, *Optimization, *Economic efficiency, Hydrologic data, Climatic data, Data collections, Statistical methods, Economics, Efficiencies, Standards, Evaluation, Systems analysis.
Identifiers: Hydrologic data networks, Error estimates.

A method is proposed for determining optimum meteorological network density for maximum economic efficiency. This requires simplifying assumptions about benefits which range from direct economic savings to water users and others who are directly involved in using data, to the intangible benefits of having a large data base for scientific work. Observation error is assumed to be identical at all stations. Formulas for computing network efficiency are listed and an example is worked using aerological data station efficiencies. (Knapp-USGS)
W69-05949

7B. Data Acquisition

INSTALLATION AND FIELD CALIBRATION OF NEWTRON-SCATTER EQUIPMENT FOR HYDROLOGIC RESEARCH IN HETEROGENEOUS AND STONY SOILS,
Department of Agriculture, University Park Pa. Northeast Watershed Research Center.
Ernest Rawitz.
Water Resources Res, Vol 5, No 2, pp 519-523, Apr 1969. 5 p, 3 fig, 9 ref.

Descriptors: *Soil moisture meters, *Nuclear moisture meters, Calibrations, On-site tests, Boreholes, Instrumentation, Equipment.
Identifiers: Neutron-scatter moisture meters, Access tubes, Stony soils.

The commonly used methods of access tube installation and neutron depth probe calibration were impractical in the stony soils of an agricultural watershed in eastern Pennsylvania. Modification of a portable power-driven drilling machine made it possible to drill straight boreholes to a depth of 24 ft through the soil and the underlying shale beds. Backfilling oversize holes around the access tubes with fine soil material gave satisfactory results. Reasonable correspondence was found between calibration curves from heterogeneous, stony sites and more precise data obtained at a site with alluvial, stone-free soil derived from the stony residual soils upstream. The field calibration curves were roughly parallel to the calibration curve supplied by the manufacturer of the probe but were displaced upward by approximately 4000 counts per minute. Use of the factory calibration curve would be adequate for determining relative changes in soil moisture content but would result in serious error if used for calculating the absolute moisture content. (Knapp-USGS)
W69-05626

AQUIFER STORAGE DETERMINATION BY RADIOTRACER TECHNIQUES,
Federal Water Pollution Control Administration, Ada, Okla.
Jack W. Keeley, and Marion R. Scalf.
Ground Water, Vol 7, No 1, pp 17-22, Jan-Feb 1969. 6 p, 9 fig, 1 tab, 10 ref.

Descriptors: *Tritium, Groundwater basins, Groundwater, *Underground water storage, *Aquifers, *Groundwater recharge, *Recharge wells, Aquifer characteristics, Recharge, *Tracers, Groundwater movement, Storage capacity, *Storage coefficient, Field tests.
Identifiers: Groundwater management, Aquifer tests, *Radioactive tracers, Ogallala formation, Groundwater hydrology.

A new method of determining aquifer storage coefficients has been developed for ground-water recharge operations through wells. Tritiated water, used as a tracer, was injected into the recharge stream continuously, rather than on a slug basis. The theory of tracer behavior is discussed and mathematical formulas are given to provide a graphical solution for the detention time. The storage coefficient is calculated from the detention time. Results from a field study on the Ogallala formation and verification by an experimental pilot test are given. The field studies give a coefficient of storage 1.4 to 2.4 times greater than reported for pumping tests in the same area. Regarding water table conditions, the method promises to produce more reliable storage values than have been obtained from pumping tests. The significance of this report lies in determining an apparent aquifer storage capacity of almost twice the volume previously estimated. (USBR)
W69-05814

CABLE AND CLAMP MODIFICATIONS FOR MODEL 104 MOISTURE PROBES,
Forest Service (USDA), Logan. Intermountain Forest and Range Experiment Station.
Bland Z. Richardson.
U. S. Forest Service Research Note INT-76 (1968): 4 p.

Descriptors: *Water levels, *Instrumentation, *Nuclear moisture meters, *Performance, *Reliability, Observation wells, Water table, Equipment, Materials, Construction, Design standards, Design.
Identifiers: *Cable clamp, *Modification, Repair, Accuracy.

Two depth moisture gages equipped with Troxler Model 104 probes were of little value in a hydrology study in north Idaho because of repeated cable failure. During the first 240 hours of operation, 200 hours were lost. The author developed a modification to remove strain from the cable wires and a new type clamp to lock the cable and probe into the standard, or to meter it out, as the case may be. Following modifications, more than 15,000 soil moisture readings were taken with these two gages without a cable failure. (Packer-Forest Service)
W69-05883

INSTALLATION OF SOIL MOISTURE ACCESS TUBES IN ROCKY SOILS,
Forest Service (USDA), Logan, Utah. Intermountain Forest and Range Experiment Station.
Bland Z. Richardson.
Journal of Soil and Water Conservation, Volume 21, No 4, (July-August, 1966): 143-145.

Descriptors: *Drilling equipment, *Boreholes, *Moisture content, *Soil moisture meters, *Radioactivity, Neutron absorption, Wells, Soil types, Rocks, Rock properties, Rock excavation, Equipment.
Identifiers: *Access tubes, Wagon drill, Hand-held drill.

Drilling holes for soil moisture access tubes in a rocky soil mantle can, without proper planning and equipment, be the most costly, inefficient phase of soil moisture studies that employ neutron scattering methods. This paper discusses requirements for drilling satisfactory access tube holes in rocky soils. It describes and illustrates problems of drilling adequate holes with hand-held rock drills, tractor-mounted drills, and crawler-mounted drills; and compares the efficiency and cost of these methods. The most satisfactory access tube holes can be obtained by using a wagon-type rock drill mounted either on a tractor or self-propelled crawler. Their cost is only about one-sixth the cost of drilling holes with hand-held equipment. (Packer-Forest Service)
W69-05887

A TOOL FOR REPAIRING INSTALLED SOIL MOISTURE ACCESS TUBES,
Forest Service (USDA), Logan, Utah. Intermountain Forest and Range Experiment Station.
Bland Z. Richardson.
Journal of Soil and Water Conservation, Volume 21, No 5, (September-October, 1966): 184.

Descriptors: *Soil moisture meters, *Tubes, *Equipment, *Construction, Maintenance, Materials, Design standards, Reliability, Performance, Materials testing, Replacement cost, Design.
Identifiers: *Access tubing, *Resize, Repair.

Frequently, when thin-walled steel or aluminum access tubes for neutron soil moisture probes are installed in the soil mantle, they become creased or dented. Snow movement downslope during the winter also dents these tubes by pressing them laterally against rocks in the upper part of the soil mantle. This paper describes and presents illustrated specifications for a resizing tool, developed by the author, to remove creases and dents from access tubes without removing the tubes from their installed positions in the soil mantle. This tool can also be used to check access tubes in place for damage. These features provide substantial savings in cost, time, and quality of soil moisture data. Without this tool, damaged access tubes would have to be replaced in newly drilled holes and the continuity of data would be interrupted. (Packer-Forest Service)
W69-05888

THE USE OF THE GEOELECTRIC METHOD FOR INVESTIGATING GEOLOGIC AND HYDROLOGIC CONDITIONS IN SANTA CLARA COUNTY, CALIFORNIA,
Santa Clara Valley Water Conservation District, Calif.
Leo M. Page.
J Hydrol, Vol 7, No 2, pp 167-177, Jan 1969. 11 p, 8 fig, 1 tab, 5 ref.

Descriptors: *Electrical studies, *Resistivity, *Surveys, *Groundwater, Geophysics, Aquifers, Water table, Water levels, Water level fluctuations, Porosity, Permeability, Transmissivity, Water yield, Discharge (Water).
Identifiers: *Santa Clara County (Calif).

The basic procedures used in electric resistivity exploration of geologic and hydrologic conditions in Santa Clara County, California are described. Typical examples of resistivity information checked against drilling and well testing are included. The advantages of the resistivity method are low cost, ease of operation, speed, accuracy, and ease of training operations. The initial cost of the equipment used was about $1,000 and the maintenance cost was about $100 per yr. Since 1964, over 800 electric soundings to depth of 200-500 ft and over 10,000 shallow profiles were made. The Wenner and Schlumberger electrode configurations are used. The usual procedure is to run a grid of profiles to learn the general geological properties of an area and then to make several probes to learn the vertical extent of the major geohydrologic zones. Recent water level conditions in the county are mapped. (Knapp-USGS)
W69-05904

CHLORIDE CONCENTRATION IN GROUNDWATER, RECHARGE RATE AND RATE OF DEPOSITION OF CHLORIDE IN THE ISRAEL COASTAL PLAIN,
Stockholm Univ. (Sweden). International Meteorological Inst.; and Department of Natural Resources, Bangkok (Thailand).
For primary bibliographic entry see Field 02F.
W69-05905

SOIL WATER MEASUREMENT WITH AN Am-241 Be NEUTRON SOURCE AND AN APPLICATION TO EVAPORIMETRY,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.
For primary bibliographic entry see Field 02G.
W69-05926

SEEPAGE FLOW ANALYSIS OF A SMALL POLDER IN THE SOUTHWESTERN PART OF THE NETHERLANDS,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 02F.
W69-05927

A RECORDING FIELD TENSIOMETER WITH RAPID RESPONSE CHARACTERISTICS,
Agricultural Research Service, Phoenix, Ariz. Water Conservation Lab.
For primary bibliographic entry see Field 02G.
W69-05931

7C. Evaluation, Processing and Publication

SENSITIVITY ANALYSIS METHOD OF SYSTEM IDENTIFICATION AND ITS POTENTIAL IN HYDROLOGIC RESEARCH,
Environmental Dynamics, Inc., Los Angeles, Calif.; and Banaras Hindu Univ., Varanasi (India).
Venkateswararao Vemuri, John A. Dracup, and R. C. Erdmann.
Water Resources Res, Vol 5, No 2, pp 341-349, Apr 1969. 9 p, 1 fig, 7 ref, 2 append.

Descriptors: *Simulation analysis, *Synthetic hydrology, *Mathematical models, *Computer models, Hydrologic data, Analog models, Analog computers, Digital computers, Systems analysis, Parametric hydrology, Statistical methods.
Identifiers: *Sensitivity analysis.

Sensitivity analysis should be an integral part of nearly every hydrologic study. At an elementary level, sensitivity analysis is useful in studying the relative sensitivity of the result to the data input. Studying the sensitivity of a hydrologic system to changes in its parameters and initial conditions makes it possible not only to gain insight into a system's behavior but to derive simple computational algorithms for the identification of unknown parameters. The fact that sensitivity analysis leads to simple initial-value problems makes it ideal for mechanization on an analog computer. The computational steps involved in implementing identification algorithms based on sensitivity analysis are relatively simpler than those based on such other methods as quasilinearization. The applicability of this method to identify both lumped and distributed hydrologic systems with deterministic or statistical input-output data is demonstrated. (Knapp-USGS)
W69-05603

SIMULATION OF EVAPORATION FROM CONSTANT SOURCE WITH FINITE AREAS,
California Univ., Los Angeles.
Chau Shih, and John A. Dracup.
Water Resources Res, Vol 5, No 1, pp 281-290, Feb 1969. 10 p, 8 fig, 1 tab, 9 ref. OWRR A-028-CAL, WRC No. W198.

Descriptors: *Evaporation, *Computer models, Mass transfer, Simulation analysis, Heat budget, Hydrologic budget, Digital computers, Analog computers, Resistance networks, Mathematical models, Convection, Diffusion, Lakes, Reservoirs, Winds, Solar radiation.
Identifiers: *Hybrid computer methods.

Evaporation from finite areas with constant sources is determined by simulating the mass transfer equation. The equation of mass transfer in a turbulent atmosphere describes the movement of mass, water vapor, and momentum. The process of transferring water vapor by evaporation from a constant source can be analyzed by the solution of this diffusion equation. A hydrid computer simulation method to solve the three-dimensional nonuniform diffusion equation is described. The proposed technique can handle any geometric configuration of lakes and reservoirs. Using a finite difference method, the partial differential equation is transformed into a set of algebraic equations. The analogy between these algebraic equations and the node equations of a passive resistance network plane makes the hybrid computer simulation technique applicable to solve problems of this type. A vertical plane, perpendicular to the direction of the wind, is simulated by a passive resistance network. The problem is solved by moving the vertical plane in the direction of the wind. Obtaining the solution using a simulation technique involves a repetitive process of observing voltages on the simulation network. The entire process is performed in the hybrid computer system using the digital computer as the control. This is a general method available to analyze the evaporation phenomena using a mathematical solution of the diffusion equation. (Knapp-USGS)
W69-05636

MATHEMATICAL MODEL AND FORTRAN IV PROGRAM FOR COMPUTER SIMULATION OF DELTAIC SEDIMENTATION,
Stanford Univ., Calif.; and Canterbury Univ., Christchurch (New Zealand).
G. F. Bonham-Carter, and Alex J. Sutherland.
Kans State Geol Surv Computer Contrib 24, Kans Univ, 1968. 56 p, 16 fig, 12 tab, 21 ref, 2 append. N00014-67-A-0112-004. Tech No. NR388-081.

Descriptors: *Computer programs, *Sedimentation, *Estuaries, *Deltas, Computer models, Alluvium, Statistical models, Mathematical models, Simulation analysis, Sediment transport.
Identifiers: *FORTRAN programs.

A FORTRAN IV program for simulating deltaic sedimentation at a single river-channel mouth is presented. A sediment-laden river flowing into a tideless, currentless marine basin is modeled as a plane jet discharging horizontally at the ocean surface. A velocity field is calculated using equations for open-channel and plane-jet flow. Sediment behavior is treated statistically; nominal sediment particles are traced along trajectories from the mouth as they spread laterally and settle vertically. The rate of sediment accumulation is calculated for each cell of a horizontal accounting grid. Input parameters include channel dimensions, water and sediment discharge, grain-size distribution and bottom topography. Experiments with a static simulation model illustrate the depositional variation produced by changes in grain size, river depth, and slope. The depositional area is narrow in plan view; in elevation, foreset slopes are a function of grain-size and hydraulic parameters, and are normally less than 1 deg. A dynamic model permits a delta platform to build forward during several time increments, nominal particle trajectories adjusting automatically to the position of the delta lip. Experiments illustrate the formation of bars building transversely across the river mouth and the development of submerged levees close to the mouth at the margins of the main flow. The FORTRAN flow chart and program listing for IBM 360 are included with test computation inputs and results. (Knapp-USGA)
W69-05657

THE FITTING OF GROWTH AND ALLIED CURVES OF THE ASYMPTOTIC REGRESSION TYPE BY STEVENS'S METHOD,
London Univ. (England). Dept. of Statistics.
R. W. Hiorns.
Tracts for Computers, No XXVIII, M S Bartlett (ed) Cambridge Univ Press, England, 1965. 52 p, 19 ref.

Descriptors: *Data processing, *Regression analysis, *Statistical methods, Population, Biology, Digital computers, Computers, Mathematical models.
Identifiers: *Growth curves, *Asymptotic regression curves, *Stevens' method, F-values, Mice, Physiology, Psychology, Learning curves, Mitscherlich's law, Compertz law, Life tables, Logistic curve, Demography, Maximum-likelihood estimators, Computation.

The problem of fitting asymptotic regression curve (FORTRAN notation) y= ALPHA+ BETA * RHO ** x, where x takes integral values 0,1,2,... (N-1), frequently occurs in practice (eg, in population studies). Report's tables facilitate fitting of this curve by W L Stevens' method, providing Stevens' F-values for ranges N= 5 (1)30 and r-sub-0= 0.10 (0.01)0.90, where r-sub-0 is a first estimate of RHO. The calculations, explained in introduction of report, may be rapidly made on a desk calculator or can be easily programmed for a digital computer. Author provides example in which growth data for mice are fitted. Method can be used for alternative models including y= ALPHA+ BETA * e ** (-GAMMA * x), growth curve of physiology and biology or learning curve of psychology; y= y-sub-0+ d * (1 - 10 ** (-k * x)), Mitscherlich's law describing fertilizer response in agriculture, and its alternative form, y= A * (1 - 10 ** (c-prime * (x+b-prime))); z= e ** (ALPHA+ BETA * RHO ** x), Gompertz law used in preparation of life tables and in economic predictions; and z= 1/ (ALPHA+ RHO ** x), logistic curve used for description of population growth in demographic studies. Author procedures for extension of method to large and small values of r, the maximum-likelihood estimate of RHO. (Eichhorn-Wis)
W69-05711

THE STRATEGY OF BUILDING MODELS OF COMPLEX ECOLOGICAL SYSTEMS,
Canadian Dept. of Forestry, Victoria (British Columbia).
For primary bibliographic entry see Field 06A.
W69-05713

THE ANALYSIS OF DETERMINATION IN POPULATION SYSTEMS,
Forest Service (USDA), New Haven, Conn. Northeastern Forest Experiment Station.
For primary bibliographic entry see Field 06A.
W69-05714

OPERATIONAL HYDROLOGY USING RESIDUALS,
Federal Water Pollution Control Administration, Washington, D. C.
For primary bibliographic entry see Field 06A.
W69-05847

LEAST SQUARES ESTIMATION OF MIXING COEFFICIENTS,
Vanderbilt Univ., Nashville, Tenn.; and Boeing Co., Huntsville, Ala.
For primary bibliographic entry see Field 06A.
W69-05862

THRESHOLD PREDICTION AND CHARACTERISTICS OF LOG-NORMAL PHENOMENA,
Northwestern Univ., Evanston, Ill. Dept. of Civil Engineering.
Edward R. Hermann.
Environ Res, Vol 1, No 4, pp 359-369, Dec 1967. 7 fig, 1 tab, 7 ref.

Descriptors: *Estimating equations, *Statistical methods, *Statistical models, Analytical techniques, Data processing, Environmental effects, Epidemics, Eutrophication, Radioecology, Streptococcus, Toxicity.
Identifiers: *Environmental health, *Log-normal distributions, *Statistical distributions, *Threshold prediction, Biological effects, Blood pressure, Chemical effects, Carcinogenesis, Data presentation, Data transformation, Gaussian distribution, Geometric mean, Industrial health, Median, Mode, Particle kinetics, Pearson's beta distribution, Psychophysical effects, Radiation effects, Toxicology, Hearing.

Measurements of many phenomena of interest in environmental health may be distributed in a log-normal manner. The zero point of occurrence (threshold) of such phenomena is important. A simple equation is derived for determining the point of origin of such distributions, based on their geometric mean, standard deviation of geometric mean, and median. Statistical methods for analyzing data and applying the equation are presented for three general cases: distributions in which (1) the origin and zero reference of measurement coincide, (2) the origin and zero reference of measurement do not coincide, and (3) the parameter of measurement is a log function and has an arbitrarily selected positive value for its reference point which is relative, not absolute. Three diverse sets of log-normal data were used to illustrate application to above cases: incubation periods observed during an epidemic of streptococcal sore throat, systolic blood pressure measurements among middle-aged industrial employees, and thresholds of hearing

among high school students. The procedures detailed can be applied to data analysis arising from research into toxicology, radiation exposure, physical or chemical stimulus responses in biological or psychophysical systems, carcinogenesis, particle kinetics, and other phenomena yielding log-normal data sets. (Eichhorn-Wisc)
W69-05871

THE ROLE OF SOME STATISTICAL AND MATHEMATICAL METHODS IN THE INTERPRETATION OF REGIONAL GEOCHEMICAL DATA,
Royal School of Mines, London (England); and Imperial Coll. of Science and Technology, London (England). Dept. of Geology.
For primary bibliographic entry see Field 02J.
W69-05895

HYDROGEOLOGIC DATA FROM FOUR LANDFILLS IN NORTHEASTERN ILLINOIS,
Illinois State Geological Survey, Urbana.
G. M. Hughes, R. A. Landon, and R. N. Farvolden.
Environ Geol Note No 26, Ill State Geol Surv, Mar 1969. 42 p, 5 fig, 8 tab, 2 ref. Grant No. 5-D01-01-00006-02.

Descriptors: *Data collections, *Land fills, *Disposal, *Illinois, Garbage dumps, Waste disposal, Leaching, Water quality, Hydrogeology, Water levels, Chemical analysis, Path of pollutants, Neutron activation analysis, Piezometers, Clays, Boreholes.
Identifiers: *Sanitary landfills, Garbage leaching.

Sanitary landfills at 4 sites in Illinois were drilled and samples of water and solid materials were analyzed to determine the hydrogeologic conditions and effects of waste disposal in glaciated terrain. The tabulated data include sites of piezometers and samples, drillers logs, sieve analyses of earth materials, clay mineral analyses, chemical analyses of leachate and groundwater, and neutron activation analyses. The landfill maps include piezometer locations, locations of cross sections, and water table contours. (Knapp-USGS)
W69-05896

MARKOV CHAIN STORAGE MODELS FOR STATISTICAL HYDROLOGY,
Cornell Univ., Ithaca, N. Y.
William H. Kirby.
Water Resources Center Pub, Cornell Univ, 1968. 155 p, 19 fig, 38 ref.

Descriptors: *Statistical models, *Mathematical models, *Markov processes, *Streamflow forecasting, Stochastic processes, Time series analysis, Reservoir storage, Water management (Applied), Probability, Unit hydrographs, Hydrograph analysis, Runoff forecasting, Digital computers, Synthetic hydrology.
Identifiers: Reservoir reliability.

The basic theory of finite Markov chains is reviewed and its application to reservoir storage problems is given. The theory provides a simple but detailed mathematical model for the serial dependence observed in hydrological phenomena, particularly when used in conjunction with time series analysis. Markov chains may be applied to reservoir design problems. Computation time is not long, making Markov models particularly useful in the preliminary stages of design. (Knapp-USGS)
W69-05917

NUMERICAL MODELING OF UNSATURATED GROUND WATER FLOW,
Kansas Univ., Lawrence.
For primary bibliographic entry see Field 02F.
W69-05918

CLIMATIC ATLAS OF THE UNITED STATES,
Environmental Science Services Administration, Washington, D. C.
For primary bibliographic entry see Field 02B.
W69-05922

A COUNTRY-WIDE STUDY OF INTENSE RAINFALL FOR THE UNITED KINGDOM,
Hydrological Research Unit, Wallingford (England).
For primary bibliographic entry see Field 02B.
W69-05925

COMPUTATION OF ANNUAL NORMAL FLOW OF INTERMITTENT WATERCOURSES AND MOUNTAIN RIVERS IN THE UKRAINIAN CARPATHIANS,
Ukrainskii Nauchno-Issledovatelskii Gidro-Meteorologicheskii Institut, Kiev (USSR).
For primary bibliographic entry see Field 02E.
W69-05950

COMPUTATIONS OF LEVEL CHANGES AND RUNOFF DISTRIBUTION IN A DELTA BASED ON OBSERVATIONAL DATA (DANUBE DELTA AS AN EXAMPLE),
State Oceanographic Institute, Moscow (USSR).
For primary bibliographic entry see Field 02E.
W69-05951

08. ENGINEERING WORKS

8A. Structures

SEDIMENT CONTROL METHODS, INTRODUCTION AND WATERSHED AREA,
American Chemical Society, New York. Hydraulics Div.
For primary bibliographic entry see Field 02J.
W69-05620

THE UDA WALAWE RESERVOIR PROJECT,
Department of Irrigation, Colombo (Ceylon). Div. of Planning, Research and Designs.
For primary bibliographic entry see Field 04A.
W69-05653

FLUID MECHANICS OF DOWNSTREAM FISH PASSAGE STRUCTURES,
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 08I.
W69-05667

REEVALUATION AND RECONSTRUCTION OF CALIFORNIA DAMS,
California State Dept. of Water Resources, Sacramento.
Clifford J. Cortright.
Prepr 771, Amer Soc Civ Eng Annu Meet, New Orleans, La, Feb 1969. 38 p.

Descriptors: *Dams, *Earth dams, *Concrete dams, Hydraulic-fill dams, Surveys, *Dam failure, Arch dams, Gravity dams, Safety, California, Dam design, Spillways, Hydraulic structures, *Rehabilitation.
Identifiers: Surveys (Data collection), *Remedial treatment.

The State of California, effectively administering a dam safety law since 1929, has found it advisable in more recent years to continuously reevaluate existing structures as experience sheds more light on dam behavior. By means of this critical inquiry, essential improvements needed in structures can be made to better ensure the growing population of the state against the consequences of dam failures. About 90 of the nearly 1100 dams in California have been identified as meriting a structural design reevaluation. Of this number, evaluation has been completed on 33 dams and a detailed investigation found necessary. Evaluation has been completed on 15 additional dams and the adequacy of the structural design has been verified. Corrective action has been ordered on 17 other dams. To date, spillway capacity reevaluation has been advised for 80 dams. Studies have been completed for 33 days and so far corrective action has been found necessary for 18 of those dams. Several examples of findings resulting from reevaluation studies and corrective action, either completed, scheduled, or determined advisable, are given. (USBR)
W69-05804

DEVELOPMENT OF TUNNELING METHODS AND CONTROLS FOR WATER RESOURCE PROJECTS,
Bureau of Reclamation, Salt Lake City, Utah.
Ellis L. Armstrong.
Pap, Amer Soc Civ Eng Water Resour Eng Conf, New Orleans, La, Feb 1969. 33 p, 16 fig, 2 tab, 1 ref.

Descriptors: *Tunnel construction, Tunnel failure, *Tunneling, Safety, *Tunneling machines, Tunnel linings, Tunnels, Cost comparisons, Laser, Cost trends, Overbreak, Rock bolts, Supports, Surveying.
Identifiers: Tunnel supports, Cost savings, Blasting.

Improvements in equipment and methods during the past 15 yr have kept tunnel excavation costs from appreciable increases while the general construction cost index has doubled. Tunnel drilling rates have increased from 20 ft/wk 100 yr ago to 100 ft/wk 50 yr ago and to about 300 ft/wk today. A milestone in tunnel driving was the 3-1/2-mi-long Fucinus Tunnel (19 ft wide and 9 ft high) started in A.D. 41 and requiring 30,000 slaves 11 yr to complete. The concept of boring machines to drill tunnels goes back to 1882, but the greatest advance has been made in the last 5 yr. A table lists the major completed mole tunneling projects. Cost savings up to 40% over conventional drill-shoot-muck cycle methods can be proven. The requirement for and types of tunnel supports being used are discussed. Improvements and advances are expected in tunnel linings because the excavation rate has surpassed the lining rate. A laser beam is an excellent control method for precision drilling with a boring machine. Tunneling safety has progressed to a satisfactory level. During a million man-hours at Blanco Tunnel, Colo, only 6 minor lost-time accidents occurred. (USBR)
W69-05815

EXPERIENCE WITH AND EVALUATION OF CRITICAL PATH METHODS,
Brown and Root, Inc, Houston, Tex.
Eric Jenett.
Chem Eng, Vol 76, No 3, pp 96-106, Feb 1969. 11 p, 3 fig, 1 tab.

Descriptors: *Critical path method, Administration, Management, Design, *Scheduling, Construction, Purchasing, *Evaluation, Flow diagrams, Logic, Computers, Resource allocation, Estimating, Mathematics, Costs, Contracts, Planning.
Identifiers: Bar graphs.

Ten yr experience with critical path methods (CPM) for scheduling the design, equipment purchase, and construction of major chemical-process plants is evaluated, including pertinent comments on pitfalls and successes with these methods. This experience covers worldwide projects of all types and sizes under a variety of conditions. General subjects discussed include: objectives of CPM, experiences from other areas, CPM and the contract, use of computers, standard CPM logic outlines, irrefutable vs desirable logic, resources and CPM, cost and CPM level of detail, coding, updating, scheduling to resources, misconstruing and limiting float, and comments on precedence diagramming. Where effective practices vary, differences are pointed out. (USBR)
W69-05817

WATER DISTRIBUTION SYSTEMS ANALYSIS,
Technion - Israel Inst. of Tech., Haifa; Massachusetts Inst. of Tech., Cambridge; and Maguire (Charles A.) and Associates, Boston, Mass.
For primary bibliographic entry see Field 06B.
W69-05848

8B. Hydraulics

SEDIMENT CONTROL METHODS, INTRODUCTION AND WATERSHED AREA,
American Chemical Society, New York. Hydraulics Div.
For primary bibliographic entry see Field 02J.
W69-05620

TRANSLATIONS OF FOREIGN LITERATURE ON HYDRAULICS.
American Society of Civil Engineers, New York. Committee on Hydromechanics.

ASCE Proc, J Hydraul Div, Vol 94, No HY6, Pap 6211, pp 1375-1382, Nov 1968. 8 p, 106 ref.

Descriptors: *Translations, *Information retrieval, *Technical writing, *Hydraulics, Water distribution (Applied), Foreign research, Turbulent flow, Hydrodynamics, Hydraulic engineering.
Identifiers: *Foreign literature, ASCE Committee on Hydromechanics.

To bring to hydraulic engineers and various water development people an up-to-date list of foreign literature translations on hydraulics, the ASCE Committee on Hydromechanics set up a task committee on translations which will from time to time issue progress reports with appropriate items. The cited list is the first one issued since the new ASCE Manual 35, 'A list of translations of foreign literature on hydraulics', was compiled on 1967. This list which contains 106 items including author, title, citation data, and file number where the report can be obtained, is considered an addendum to Manual 35. The Manual will be revised periodically. (Lang-USGS)
W69-05655

REEVALUATION AND RECONSTRUCTION OF CALIFORNIA DAMS,
California State Dept. of Water Resources, Sacramento.
For primary bibliographic entry see Field 08A.
W69-05804

DIVERSION WORKS FOR CONSTRUCTION,
U S Army Corps of Engineers, Vicksburg, Miss.
For primary bibliographic entry see Field 04A.
W69-05816

LONG STANDING WAVES IN A CURVED CANAL,
Reading Univ. (England).
B. Johns, and A. M. O. Hamzah.
J Fluid Mech, Vol 34, Part 4, pp 759-768, Dec 1968. 10 p, 2 fig, 1 tab, 6 ref.

Descriptors: *Standing waves, *Canals, *Curves, Hydraulics, Estuaries, Canal design, Tsunamis, Waves (Water), *Bends, Oscillation.
Identifiers: Tidal waves.

The dynamics of long water waves are considered in a curved geometry representing a canal bend. The presence of the bend produces a spectrum of transverse oscillations in the canal. Associated dominant amplitudes are evaluated for tidal periods and higher frequencies representative of tsunamis. Low-frequency waves do not lead to significant transverse amplitudes. For tsunamis, the presence of the bend may result in considerable changes in the local wave amplitude. (USBR)
W69-05827

SURGE FLOW: A MODEL OF THE WALL LAYER,
Florida State Univ., Tallahassee. Dept. of Geology.
William F. Tanner.
Southeastern Geol, Vol 10, No 2, pp 93-110, Apr 1969. 18 p, 2 fig, 1 tab, 13 ref.

Descriptors: *Unsteady flow, *Waves (Water), *Boundary layers, Currents (Water), Erosion, Ripple marks, Sedimentary structures, Reynolds number, Froude number, Laminar flow, Turbulent flow, Hydraulic models.
Identifiers: *Kinematic waves, Surge flow.

Thin sheets of flowing water were studied on various inclined surfaces, including smooth glass, asphalt, concrete, wood, loose sand and fixed sand grains. Flow was accompanied by more-or-less regular surges. Controlled variables were slope angle, discharge, surface roughness, surface tension and viscosity. Surges initially constitute an almost-random phenomenon; they are quickly modified by surface tension and other effects and become regular in geometry and speed. Similar features have been studied in the thin wall layer in a smooth-bottomed tilting flume. The very low shear ridges, which actually appear under water on sand beds before individual grain motion is visible, are thought to be caused by the wall layer equivalent of thin sheet surge flow. Such ridges, once formed, require rapid development of bottom eddies, which shape the ridges into ordinary sub-aqueous ripple marks. If this is correct, a form of surge flow in the wall layer is responsible for initiation of sediment particle motion. Work with tracers also indicates that the regime in the wall layer is laminar but rapid, and that initiation of sediment motion is a Froude phenomenon; once subaqueous ripple marks develop, continuation of sediment transport is a Reynolds phenomenon. Observation of natural thin sheet flow, over mobile granular beds, shows that any one of the several Froude regimes can form preservable sand surface markings which are not ripple marks. (Knapp-USGS)
W69-05892

8C. Hydraulic Machinery

COMPARATIVE MODEL TURBINE TESTS,
Demers (George), Consulting Engineers (Quebec).
Ronald E. Passmore.
Water Power, Vol 21, No 1, pp 26-30, Jan 1969. 5 p, 4 ref.

Descriptors: *Hydraulic turbines, *Efficiencies, *Model tests, Losses, *Specifications, Acceptance testing, Laboratory tests, Test facilities, Francis turbines, Structural design, Mechanical properties, Prototypes, Foreign research, Models, Pelton turbines, *Test procedures, Hydraulic design, Bids, Design standards, Manufacturing, *Hydraulic models.
Identifiers: Canada, Procedures, Test results.

Many points are taken into consideration when preparing specifications for selecting turbines on the basis of comparative model tests. When drafting specifications of this type, various items should be discussed with as many prospective bidders as possible to obtain a concensus and avoid later controversy. Where differences of opinion remain, the purchaser or consulting engineer should seek the advice of the laboratory, but must be guided by his own judgment. Those parts of the specification that are solely within the province of the laboratory can be dealt with only after the performing laboratory has been identified. Completeness is essential and cannot be overemphasized. Even then there will be bids that are noncompliant either by stipulating conditions different from those specified by the purchaser, or by containing contrived or accidental ambiguities and conflicting statements. These must be resolved before the contract is awarded if later disputes are to be avoided. A well-planned program of comparative testing automatically eliminates such areas of uncertainty. (USBR)
W69-05806

DAMPING OF SWITCHING OVERVOLTAGES IN EHV-NETWORKS--NEW ECONOMIC ASPECTS AND SOLUTIONS,
Brown, Boveri and Co. Ltd., Baden (Switzerland).
P. A. Baltensperger, and P. Djurdjevic.
Trans Pap No 69 TP 36-PWR, Inst Elec Electron Eng Winter Power Meet, New York, N Y, Jan 1969. 12 p, 11 fig, 3 tab, 5 ref.

Descriptors: *Extra high voltage, *Circuit breakers, Thermal stress, *Resistors, Costs, Lightning arresters, Transmission lines, Economics, *Closing, Damping, Capacitors, Foreign research, *Electric insulation.
Identifiers: *Switching surges, Shunt reactors, Spark gaps, Switching, *Overvoltage, Switzerland.

Insulation is important in ehv networks having nominal voltages of 765 kv and above. An upper physical limit exists for the insulation strength that cannot be increased by reasonable technical methods. Costs of achieving an insulation level near this limit are high. Limiting overvoltages from all sources to an acceptable value by some method other than insulation is necessary. Closing resistors on circuit breakers is an effective way of damping closing overvoltages. This report discusses the use of closing resistors and presents a new application that separates resistors from breakers. Technical and economic advantages of separate resistors are given. One attractive feature of the scheme permits limiting closing overvoltages and damping voltage oscillations on the line upon interruption, avoiding a trapped charge.
W69-05809

CORONA MEASURING TECHNIQUES FOR POWER TRANSFORMERS,
Westinghouse Electric Corp., Muncie, Ind.; and Westinghouse Electric Corp., Pittsburgh, Pa.
H. R. Moore, V. L. Boaz, and T. W. Dakin.
Conf Pap 69 CP 34-PWR, Inst Elec Electron Eng Winter Power Meet, New York, N Y, Jan 1969. 10 p, 11 fig, 1 tab, 7 ref.

Descriptors: *Power transformers, *Electrical coronas, Attenuation, Electrical equipment, Radio interference, Quality control, *Measurement, Characteristics, Electric insulation, Electric potential, Oscillographs, Faults (Electrical), Instrumentation, Pulses, Voids, Calibrations, Laboratory tests.
Identifiers: Dielectric properties, *Electric discharges.

Factors influencing the observed level of corona or partial discharge measurements on large power transformers are discussed. Corona measurements are usually made with 1-megahertz radio influence voltage meters coupled to the potential tap of condenser-type bushings. This is a worthwhile method for quality control corona tests if sufficient data and experience are available to interpret test results. Measuring picocoulomb pulse magnitudes with an integrating-type detector offers hope for achieving more accurate comparison of discharges in different transformer windings and with insulation models, considering the coupling factor from the discharge site to the measurement terminal. Principles involved in the picocoulomb pulse magnitude method are discussed. (USBR)
W69-05810

A NEW SURGE-LIMITING DEVICE FOR HIGH VOLTAGE STATIONS,
Duke Power Co., Charlotte, N.C.
Herman B. Wolf.
Conf Pap No 69 CP 93-PWR, Inst Elec Electron Eng Winter Power Meet, New York, N Y, Jan 1969. 6 p, 5 fig.

Descriptors: *Resistors, *Capacitors, Lightning arresters, *Surges, Electrical equipment, Field tests, Lightning, Switchyards (Electrical), Transmission (Electrical), Capacitance, Failures, Electric insulation, Laboratory tests.
Identifiers: *Switching surges, *Spark gaps, *Overvoltage, *Protection (Electrical), *Switching, Flashover, Lightning protection.

A new device is described for limiting the surge voltage rise on a high-voltage bus to a predetermined maximum value, without chopping action. Experience based on 11 yr operation of four 3-phase protective capacitor installations (2 on 100-kv buses and 2 on 44-kv buses) provided background data for developing the surge-limiting device. Power laboratory tests indicate that desired surge protection can be realized with no 60-hertz follow current. The device will limit surge voltage from lightning and switching surges on high-voltage buses to a predetermined maximum value so that equipment having reduced BIL may be safely used. When this device is used with such equipment, the protection ratio will be as great or greater than the protection ratio achieved when full BIL equipment is used with modern lightning arresters. The device will reduce the rate of voltage rise of a surge appearing on the high-voltage bus; continuously connected capacitors add kvac to the system. (USBR)
W69-05811

INFLUENCE OF SHUNT REACTORS ON SWITCHING SURGES,
Centro Elettrotecnico Sperimentale Italiano, Milan.
A. Clerici, G. Ruckstuhl, and A. Vian.
Conf Pap No 69 CP 116-PWR, Inst Elec Electron Eng Winter Power Meet, New York, N Y, Jan 1969. 14 p, 14 fig, 1 tab, 7 ref, append.

Descriptors: Extra high voltage, *Circuit breakers, Resistors, Faults (Electrical), *Transmission lines, Closing, Transmission (Electrical), *Surges, Electric insulation, *Transients, Oscillation, Losses, Foreign research, Analysis, Inductance.
Identifiers: Italy, *Switching surges, *Shunt reactors, *Overvoltage, Switching.

On the basis of transient network analyzer studies, the influence of ehv shunt reactors on overvoltages occurring during breaker operations on transmission systems is discussed. The comparative importance of line losses and reactor losses on the decay of trapped charge voltages oscillating at frequencies governed by line capacitances and shunt reactor inductances is analyzed. Emphasis is placed on the influence on these trapped charge voltage oscillations of different types of faults and line asymmetries. Overvoltages following closing and reclosing operations on different ehv systems with and without shunt compensation are studied. A detailed investigation on two 500-kv lines permits conclusions to be drawn about the effect of shunt reactors in reducing maximum overvoltages and their cumulative frequency distribution, and about the influence of shunt compensation on optimization of preinsertion resistors. Some reduction in reclosing surges on shunt-compensated lines is evidenced. (USBR)
W69-05812

EXPERIENCES ON STARTUP AND TRIAL OPERATION AT YARDS CREEK PUMPED STORAGE PROJECT,
Jersey Central Power and Light Co., Morristown, N. J.; and Tippetts-Abbett-McCarthy-Stratton, New York.
R. J. Swed, and K. H. Yang.
Pap No 68-WA/FE-14, Amer Soc Mech Eng, Winter Annu Meet, New York, N Y, Dec 1968. 9 p, 9 fig.

Descriptors: *Pumped storage, *Operation and maintenance, Water hammer, Pump turbines, Automatic control, Supervisory control (Power), Pumping, Generators, Electric motors, Hydraulic machinery, Electrical equipment, *Vibrations, Instrumentation, Acceptance testing, Field tests, *Noise.
Identifiers: *Yards Creek Project (Del), Pump-generators, Load rejection, Generator-motors.

Startup and trial operation problems encountered at Yards Creek Pumped Storage Project, Del, are discussed; solution methods are given. The Yards Creek installation consists of 3 vertical reversible pump turbine units rated 150,500 hp each as turbines under 656-ft minimum net head. As a pump, each unit will require an input of 186,000 hp at 691-ft minimum total dynamic head for a discharge of 2175 cfs. Initially, Unit 3 was operated as a pump, and balanced in this mode of operation until runout readings of the shaft were acceptable. After sufficient water was stored in the upper reservoir, the unit was run in the generating mode; shaft runout was excessive and rebalancing was required, resulting in a need to compromise the balance for both modes of operation. This is only one problem encountered with these pumped storage units. Other problems are covered to stimulate exchanging experiences as a help in developing the art of pumped storage. (USBR)
W69-05824

8D. Soil Mechanics

SURVEY OF WATER INDUCED LAND-INSTABILITY HAZARDS IN THE PORTLAND, OREGON REGION,
Portland State Coll., Oreg. Dept. of Earth Science; and Oregon State Univ., Corvallis.
Leonard Palmer.
Water Resources Res Center Final Rep, Jan 1, 1969. 8 p, 1 map. OWRR Project A-004-OREG.

Descriptors: *Landslides, *Hydrologic aspects, *Oregon, Debris avalanches, Mud flows, Mass wasting, Disasters, Earthquake engineering, Land subsidence.
Identifiers: Land instability hazard, Portland (Ore).

A survey of water induced land-instability hazards in the Portland, Oregon region was conducted from January through June, 1968. Existing information on such hazards was compiled from government, industrial and private sources. Hazards were found to be more extensive than previously recognized. Problem areas were surveyed during severe storm periods to observe hazards, and during fair weather to learn recognition of potential hazards. It was found that land-instability hazards occur predominantly in the winter rainy season and are directly related to hydrologic conditions, and urban expansion increases the severity of most types of hazards by disturbing the natural hydrologic and physiographic processes. Debris flooding and earth sliding are intensified by increased run-off and by disrupted subsurface water conditions following construction of structures in hazard areas. The study of distribution of hazards can allow remedial zoning and building control to reduce the hazard potential. The mechanisms and natural conditions in hazard areas are only generally recognized, but they appear to be related to surface processes and subsurface materials as affected by water conditions. The geohydrologic conditions which allowed most of the property damage in the Alaskan Good Friday earthquake of Mar 27, 1964 show great similarity to conditions in Portland. Densely populated areas, hospitals, dams and civic buildings are located in Portland's hazard potential sites. Urban expansion causes disruption of the natural hydrologic conditions by sewage and run-off changes which activate serious hazards to life and property. (Knapp-USGS)
W69-05640

VICTOR A HARDER REALTY AND CONSTRUCTION CO V CITY OF NEW YORK (DAMAGES CAUSED BY EXCAVATION AND GROUNDWATER REMOVAL).
For primary bibliographic entry see Field 06E.
W69-05786

MONTELEONE V BOH BROS CONSTRUCTION CO (LIABILITY FOR DAMAGE CAUSED BY PILE DRIVER VIBRATIONS).
For primary bibliographic entry see Field 06E.
W69-05799

SETTLEMENT JOINTS IN BAIGUL DAM SPILLWAY,
A. N. Harkauli, M. M. L. Khanna, and H. S. S. Singhal.
Irrig Power, India, Vol 25, No 3, pp 281-289, July 1968. 9 p, 3 fig, 4 ref.

Descriptors: *Earth dams, *Settlement, *Spillways, *Joints, Foundation investigations, *Differential settlement, Bearing capacities, Unconfined compression, Consolidation, Foreign design practices, Internal friction, Cohesion, Water stops, Rigid foundations, Dam foundations, Hydraulic structures.
Identifiers: Bearing pressure, Foundation modulus, Baigul Dam (India), India.

The magnitude of anticipated settlement under the piers, crests, and wingwalls of Baigul Dam spillway required dividing the structure by settlement joints. Baigul is a homogeneous earth dam with a maximum height of 36 ft. The upper 10-15 ft of the foundation is loose sandy silt or silty clay with a penetration resistance of less than 10. Large differential settlements between various parts of the structure were expected because of differences in bearing pressures (2 tons/sq ft for wingwalls and 1.5 tons/sq ft for piers). Using a load of 2 tons/sq ft and an average thickness of 20 ft, the clay layer could consolidate 7 in. with 50% of this settlement occurring in 1 yr. Unconfined compression tests determined the allowable bearing capacity of the clay layer. The depth of foundation concrete was kept to a value that allowed it to behave as a rigid foundation. Settlement joints utilized copper seals containing loops to take the differential settlements. The length of the loop was 2-3 in. more than the calculated total settlement. Details of various settlement joints are given. (USBR)
W69-05819

EXPERIMENTAL INVESTIGATION OF THE ACTIVE PRESSURE OF A CLAY SOIL ON A RETAINING WALL,
B. L. Tarasov.
Soil Mech Found Eng, No 2, pp 78-80, Mar-Apr 1968. 3 p, 4 fig, 4 ref.

Descriptors: *Active pressures, Lateral forces, *Earth pressure, Model studies, Eluvium, Foreign research, *Retaining walls, Density, Pressure gages, Soil mechanics, Wall friction, Poisson ratio, Cohesive soils, Clays, Displacements.
Identifiers: *At rest pressure, USSR, Rigid structures, Coulomb theory.

Lateral pressure of an eluvial soil on a rigid retaining wall is appreciably greater than the so-called active pressure. Lateral pressure of 2 types of eluvial soil on rigid and movable retaining walls was studied. Design of the test apparatus allowed lateral wall movement and rotation around the upper or lower edge. Soil pressure was measured with resistance gages and lever tensiometers. Greased artificial parchment paper was used to reduce friction between the soil and the tank's side walls. An increase of 7% in dry bulk density of loose soil produced a 35% increase in lateral pressure. Pressure exerted by dense filling agrees with at rest pressure calculated from the lateral pressure coefficient corresponding to Poisson's ratio. Lateral pressure on a rigid wall varies linearly with height, except at the bottom where there is a marked pressure reduction. A slight movement of the wall (o.5-1.0 mm) causes a sharp reduction and vertical redistribution of pressure. Active pressure must not be used to calculate thrust on a retaining wall that cannot move appreciably or is attached rigidly to other immovable structures. (USBR)
W69-05820

SHRINKAGE CHARACTERISTICS OF SOIL-CEMENT MIXTURES,
Mississippi Univ., University.
Kalankamary P. George.
Highw Res Rec, No 255, pp 42-58, 1968. 17 p, 11 fig, 4 tab, 18 ref.

Descriptors: *Soil cement, *Shrinkage, Clay minerals, Montmorillonite, Soil moisture, Soil strength, Optimum moisture content, Cracks, Density, Swelling, Kaolinite, Latticework, Measuring instruments, Bibliographies, Compaction, Moisture content, Capillary action, Adsorption, Curing, Soil mechanics.
Identifiers: Soil suction, Cement content, Capillary tension.

Ten soil samples representing a range in grain size, gradation, and mineralogy were studied to provide information on factors affecting shrinkage and the mechanism of shrinkage cracking. Linear shrinkage of 3- by 3- by 11-1/4-in. molded soil-cement beams at different cement contents was measured at prescribed intervals. For the soils studied, shrinkage varied with the cement content such that an optimum content can be found giving the least amount of shrinkage and providing satisfactory strength. Total shrinkage appears to be a function of the amount and kind of clay, with montmorillonite contributing more than other types. Shrinkage of soil-cement can be considerably reduced by compacting to higher densities. Molding moisture has the most influence on shrinkage caused by loss of moisture. Increasing the mixing temperature from 75 to 100 deg F tends to increase shrinkage. Shrinkage forces set up by the tension in capillary water account for the volume change at fairly high humidities. The liquid-adsorption phenomenon relates shrinkage and swelling to the interaction between soil grains and water. Changes in lattice spacing of the clay minerals with moisture is a third mechanism affecting shrinkage. (USBR)
W69-05825

PILE TESTS GUIDE FOUNDATION DESIGN,
Lowry and Associates, Sacramento, Calif.
Thomas S. Wallace.
Found Fact, Vol 4, No 2, pp 8-11, 1968. 4 p, 6 fig, 2 tab.

Descriptors: Foundations, Buildings, *Foundation investigations, *Pile foundations, Pile bearing capacities, Pile driving, Pile friction, Piles (Foundations), Settlement, Tapers, Steel piles, *Friction piles, Soil properties, Rebound, Penetration resistance, Water table.
Identifiers: *Pile tests.

Piles having capacities up to 100 tons real load were recommended for a 12-story building in Stockton, Calif, as a result of on-site pile load tests. Ultimate interior column loadings will exceed 1400 kips dead-plus-live load; an equivalent uniform pressure throughout the building will be 4500 to 5000 psf. The foundation is highly stratified alluvial deposits of silty clays, clayey silts, silty sands, and clear sands. The cohesionless soils are medium-dense to dense; the cohesive soils are stiff to very stiff. The ground-water table is 54 to 56 ft below ground surface. Laboratory tests indicated that piles embedded approximately 50 ft would develop the design capacity through frictional resistance of at least 80 tons. The pile test program included 2 step-taper piles, an H pile, and a pipe pile. All piles were driven with a differential steam hammer having an 8000-lb ram and a rated energy of 24,450 ft-lb. Driving records for each pile are given. Test loads were applied in 37.5- and 50-ton increments with intermediate rebound points. Load settlement curves are given for test piles. The best performing pile was a step-taper pile with an 11-1/4-in.-dia tip. This pile was embedded 50.3 ft and sustained a 24-hr loading of 300 tons with a deflection of 0.88 in. (USBR)
W69-05843

LABORATORY LOAD TESTS ON BURIED FLEXIBLE PIPE - PROGRESS REPORT NO 1,
Bureau of Reclamation, Denver, Colo.
A. K. Howard.
Bur Reclam Rep No EM-763, June 1968. 62 p, 44 fig, 6 tab, 7 ref, append.

Descriptors: *Pipelines, Backfill, Soil mechanics, Cohesive soils, Underground structures, Pressure measuring instruments, Test procedures, Laboratory tests, *Soil pressure, Strain gages, Embankments, Deflection, Lateral forces, Pressure sensors, *Steel pipes, Pipes, Deformation.
Identifiers: *Flexible pipes, Reinforced plastic mortar pipe, *Buried pipes, Pressure cells, Progress reports, Loading tests.

As part of a study on soil factors affecting the behavior of buried pipe, the Bureau of Reclamation is conducting research on the soil-structure interaction of buried flexible pipe. The main items of investigation on flexible pipe are soil pressures on the pipe and load-deflection relationships. Five load tests were performed on bare steel pipe and one test on reinforced-plastic mortar pipe. Pipes are buried in a portable soil container 7 ft deep, 6 ft wide, and 7 ft long, with surcharge applied to the surface of the soil by a large universal testing machine. Measurements of soil pressures on the pipe and soil container walls, changing dimensions of the pipe, soil movement around the pipe, and strain on the inner surface of the pipe are made during a 1-day loading sequence. The program eventually will cover tests on 18-, 24-, and 30-in.-dia steel pipe with wall thickness of 7, 10, and 14 gage. Further tests on reinforced-plastic mortar pipe will be included. (USBR)
W69-05845

GENERAL REPORT ON SHALLOW FOUNDATIONS, DEEP FOUNDATIONS WITHOUT PILES, PILE FOUNDATIONS,
Duke Univ., Durham, N. C.
Aleksandar S. Vesic.
Pap, Soil Mech Ser No 9, Duke Univ, Durham, N C, 1967. 33 p, 1 fig, 1 tab, 29 ref.

Descriptors: *Foundations, Foundation bearing tests, Preconsolidation, Pressure distribution, *Settlement, Consolidation, Bibliographies, *Pile foundations, Differential settlement, Expansive soils, Soil properties, Elasticity modulus, Elastic deformation, Footings, Soil mechanics, Pile friction, Penetration resistance, Bearing capacities.
Identifiers: Foundation modulus, In situ tests, Loading tests, Elastic foundations, Deformation modulus.

This report discusses 5 topics: (1) settlement of shallow foundations, (2) site preparation by preloading, (3) contact pressure distribution under foundations, (4) theory of deep foundations, and (5) tests on deep foundations. The conventional method of predicting consolidation settlement, based on confined compression tests in the laboratory, has been perfected to the point where an expected accuracy of plus or minus 20% can be claimed. Parameters from in situ tests should be used for the settlement analysis of foundations resting on cohesionless soils. Most analyses of pressure distribution at the contact between the foundation and the bearing soil layer are being made using the assumption that the soil behaves elastically. Effects of superstructure rigidity and variations in soil compressibility on contact pressure distribution are discussed. In some cases, expansive soils contribute more to differential settlement than deformation from newly imposed loading. An assessment of principal trends in the field of deep foundations is given. A new improvement in load test procedures of deep foundations is the constant-rate-of-penetration procedure, offering definite practical advantages over the established quasi-long term constant-stress-increment procedure. (USBR)
W69-05846

8E. Rock Mechanics and Geology

SURVEY OF WATER INDUCED LAND-INSTABILITY HAZARDS IN THE PORTLAND, OREGON REGION,
Portland State Coll., Oreg. Dept. of Earth Science; and Oregon State Univ., Corvallis.
For primary bibliographic entry see Field 08D.
W69-05640

MONTELEONE V BOH BROS CONSTRUCTION CO (LIABILITY FOR DAMAGE CAUSED BY PILE DRIVER VIBRATIONS).
For primary bibliographic entry see Field 06E.
W69-05799

SURGE FLOW: A MODEL OF THE WALL LAYER,
Florida State Univ., Tallahassee. Dept. of Geology.
For primary bibliographic entry see Field 08B.
W69-05892

8F. Concrete

BUREAU OF RECLAMATION EXPERIENCE WITH FROST ACTION ON CONCRETE,
Bureau of Reclamation, Denver, Colo.
Graydon E. Burnett, and Leland C. Porter.
Prepr, RILEM Int Symp Durability Concr, Prague, Czech, Sept 1969. 19 p, 10 fig, 12 ref.

Descriptors: Concretes, *Concrete testing, *Concrete technology, Frost action, Concrete mixes, Durability, *Freeze-thaw tests, Freezing, Test procedures, Laboratory equipment, Laboratory tests, Air entrainment, Air void ratio, Reviews, Test specimens.
Identifiers: Concrete properties, Freeze-thaw cycle, Frost resistance, *Freeze-thaw durability, Testing equipment, Concrete deterioration.

The development of freezing and thawing tests for concrete by the Bureau of Reclamation over the past 35 yr is reviewed. Tests were conducted manually from 1934 to 1946. Effects of varying temperatures and freezing cycles were evaluated and methods for evaluating concrete durability were studied. By the mid-1940's, freeze-thaw testing of concrete was adopted as an acceptance test for concrete aggregates and automatically controlled equipment was built. The apparatus tests 3-in.-dia specimens contained in rubber tubes and covered with tap water. Test specimens are alternately frozen and thawed by recirculating refrigerated brine and heated brine systems. A large walk-in air-freeze and water-thaw apparatus was built in 1956 to achieve greater flexibility for testing large or unusually shaped specimens and for varying the period of freezing and thawing. Results of freeze-thaw studies are summarized on air entrainment, effects from fineness of grinding portland cement, correlation with sodium sulfate soundness tests, and correlation with field performance. Exact correlation between laboratory tests and field performance has not been achieved because of the many variables that cannot be fully evaluated. (USBR)
W69-05801

CONCRETE--A NON-ELASTIC MATERIAL IN THE LABORATORY AND IN STRUCTURES,
Leeds Univ. (England).
Adam M. Neville.
Stanton Walker Lect No 6, Univ Maryland, College Park, Nov 1968. 20 p, 14 fig, 18 ref.

Descriptors: Concretes, *Concrete structures, Concrete technology, Concrete testing, Reinforced concrete, *Creep, Strength of materials, Brittle failures, Ductility, Elastic deformation, *Deformation, Stress, Elasticity modulus, Inelastic action, Foreign research, Design criteria, Strain, Bibliographies.
Identifiers: *Concrete properties, Great Britain, Cyclic loads, Design assumptions, Design practices, Stanton Walker Lectures.

Nonelastic properties of concrete as a structural material are reviewed in the 1968 Stanton Walker Lecture. Concrete is not a brittle material in the sense that materials are so considered when only a small strain develops before fracturing. Large strains may develop in concrete prior to fracturing, resulting in comparatively ductile failures in reinforced concrete columns and beams. If concrete were purely elastic and brittle, structural concrete failures would be too sudden and catastrophic for

use in highly statically indeterminate structures. The ductile behavior of concrete has contributed to the success of concrete as a structural material and is attributed to the ability to undergo creep. To determine whether actual properties of concrete differ significantly from assumed properties, 4 topics are discussed: nonelasticity of concrete in design; modulus of elasticity variations with time and stress; behavior of concrete under cyclic loading and under combined cyclic and sustained loads; and creep and creep Poisson's ratio under triaxial compression. There are no major discrepancies between design assumptions and reality because nonelasticity of concrete permits adjustment and accommodation so that dangerous unrelieved stresses are not induced. (USBR)
W69-05822

NONDESTRUCTIVE CONCRETE TESTS--GRAND COULEE SPILLWAY BRIDGE,
Bureau of Reclamation, Denver, Colo.
G. G. Hoagland.
Bur Reclam Rep No C-1299, Nov 1968. 30 p, 20 fig, 8 tab, 3 ref.

Descriptors: *Non-destructive tests, *Concrete testing, *Impact tests, Concrete structures, Wave velocity, Core drilling, Compressive strength, Arch bridges, Elasticity modulus, Keyways, Field tests, Deterioration, Concretes, Bridges, Ultrasonics.
Identifiers: Grand Coulee Spillway Bridge (Wash), *Sonic velocity tests, Soniscopes, Schmidt test hammer, *Impact hammers, Concrete properties.

Nondestructive sonic pulse velocity and impact hammer tests were conducted on the Grand Coulee Spillway bridge. Results were correlated with those from a small number of 6-in.-dia cores from noncritical areas to evaluate the bridge concrete. Additional tests were performed on concrete in areas showing minor distress. The concrete in the bridge is in excellent condition, having a compressive strength of 8700 psi (612 kg/sq cm) in the deck and 7630 psi (536 kg/sq cm) in the vertical walls. Pulse velocities indicate that the arch concrete is high quality and that concrete in the deck is slightly lower in quality, probably because of minor deterioration of the surface caused by traffic. (USBR)
W69-05823

CONCRETE-POLYMER MATERIALS, FIRST TOPICAL REPORT,
Brookhaven National Laboratory, Upton, N. Y.; Bureau of Reclamation, Denver, Colo.
M. Steinberg, J. T. Dikeou, L. E. Kukacka, J. E. Backstrom, and P. Colombo.
Brookhaven Nat Lab Rep BNL 50134 (T-509) and Bur Reclam Gen Rep 41, Dec 1968. 83 p, 43 fig, 55 tab, 14 ref. Available from Clearinghouse as BNL 50 134 at $3.00 in paper copy and $0.65 in microfiche.

Descriptors: *Concrete technology, Concrete mixes, Concrete testing, *Concretes, *Composite materials, Concrete structures, *Impregnation, Building materials, Materials, Materials engineering, Polymers, Chemical properties, Physical properties, Construction materials.
Identifiers: *Polymerization, *Concrete-polymer materials, Polymethyl methacrylate, Concrete properties, Corrosion resistance, Polystyrene.

The preparation, testing, and development of composite concrete-polymer construction materials are under investigation by a joint program of the Brookhaven National Laboratory and the Bureau of Reclamation, with the assistance of the Atomic Energy Commission and Office of Saline Water. Preformed air-entrained concrete and mortar can be fully impregnated with a monomer polymerized in situ either by radiation or thermalcatalytic techniques. Tests of polymethyl-methacrylate and polystyrene-impregnated concrete show improvements of: (1) 285% increase in compressive strength, (2) 292% increase in tensile strength, (3) 80% increase in modulus of elasticity, (4) 256% increase in modulus of rupture, (5) 44% increase in flexural modulus, (6) over 300% increase in freeze-thaw resistance, (7) 73% increase in impact hammer test values, (8) decrease in water permeability to negligible values, (9) up to 95% decrease in water absorption, and (10) negligible corrosion in distilled water and sulfate brines. Potential applications of concrete-polymer include: sewer and pressure pipe, building materials for housing and underwater structures, corrosion-resistant concrete for desalting plants, and antifragmentation concrete. (USBR)
W69-05835

8G. Materials

APPLICATION TECHNIQUES, PHYSICAL PROPERTIES, AND CHEMICAL RESISTANCE OF CHLORINATED RUBBER COATINGS.
National Association of Corrosion Engineers, Houston, Tex.

Mater Prot, Vol 8, No 1, pp 48-51, Jan 1969. 4 p, 3 tab.

Descriptors: Coatings, Corrosion control, Chemical properties, *Paints, *Protective coatings, *Painting, Physical properties, Rubber, Primers (Painting), Maintenance, Application methods, Operation and maintenance, Formulation.
Identifiers: *Chlorinated rubber, Corrosion environments, Film coverage, Chemical resistance, *Corrosion resistance, Surface preparation.

Chlorinated rubber coatings are reviewed by the National Association of Corrosion Engineers, Task Group T-6B-9, to provide information on performance and limitations of various organic materials used in these coatings. The report defines chlorinated rubber and discusses formulation for maximum chemical resistance. Properties of the paint and applied coatings are summarized. Resistance to various chemicals and exposure conditions is discussed; a table presents recommendations for exposure to many chemicals. Ratings are based on 2-wk immersion tests and field experiences. Shipping data and safety precautions are included. Recommendations are provided for surface preparation, priming, and application methods. Film thickness, weight of applied coatings, and coverage are given. Coatings of a specific generic type and different manufacture will vary in corrosion resistance, depending on the modifiers, type of pigment, and other formulation variables. This report considers average properties only. (USBR)
W69-05808

CONCRETE-POLYMER MATERIALS, FIRST TOPICAL REPORT,
Brookhaven National Laboratory, Upton, N. Y.; Bureau of Reclamation, Denver, Colo.
For primary bibliographic entry see Field 08F.
W69-05835

8H. Rapid Excavation

VICTOR A HARDER REALTY AND CONSTRUCTION CO V CITY OF NEW YORK (DAMAGES CAUSED BY EXCAVATION AND GROUNDWATER REMOVAL).
For primary bibliographic entry see Field 06E.
W69-05786

FORMATION OF UNDERGROUND CAVITIES BY THE USE OF EXPLOSIVES,
A. S. Dobina, and N. A. Evstropov.
Transp Stroit, No 4, pp 47-49, 1966. Transl from Russ, Bur Reclam Transl 800, Feb 1969. 9 p, 1 fig, 1 ref.

Descriptors: *Foreign construction, Charges (Explosives), Field tests, Explosives, Engineering geology, Excavation, Soil mechanics, Clays, Soil structure, *Underground, *Underground explosions, Blasts, Delay elements (Explosives), *Underground storage, Storage, Methodology, Soil physical properties, Time, Depth, Drill holes, Plasticity, Explosions.
Identifiers: USSR, *Underground cavities, *Explosive construction, *Construction methods, Stemming, Spacing, Rapid excavation.

Researchers in the USSR used triple-stage conventional underground explosions in drill holes to construct underground storage cavities. This method is quantitatively and qualitatively satisfactory for storage of fuels, and would be applicable to other types of storage and construction, such as tunnels, canals and trenches, and large-volume excavation work. Plastic clay soils can be compacted by explosions to prevent seepage of stored material provided the clays contain no inclusions that might contaminate the stored media. Maximum increase in soil density approached 40% of initial density; initial mechanical properties, such as unconfined compressive strength and cohesion, increased 4 times. The technology and formulas for enlarging original drill holes by successive explosions after preliminary soil-cement grouting of the overlying area are discussed. The size of resulting strong watertight cavities depends on the size of explosive charges and soil compressibility. Cavities can be constructed singly or simultaneously in groups, using the information and formulas given. Field tests were conducted in Scythian and Cambrian clays and morainic clayey soils. (USBR)
W69-05818

8I. Fisheries Engineering

FLUID MECHANICS OF DOWNSTREAM FISH PASSAGE STRUCTURES,
Washington Univ., Seattle. Dept. of Civil Engineering.
E. P. Richey.
Proj Completion Rep, Charles W. Harris Hydraul Lab Tech Rep No 22, Sept 1967. 7 p, 3 ref. OWRR Project A-004-WASH.

Descriptors: *Fish guiding, *Open channel flow, *Hydraulic models, Fish behavior, Fish migration, Fish ladders, Fish passages, Fish management, Model studies, Unsteady flow, Supercritical flow, Turbulent flow, Non-uniform flow.
Identifiers: Spatially varied flow.

The hydraulic characteristics of flow over an inclined, porous plane of a type used as a fish passage facility, and the hydraulic indices of guidance stimuli associated with a converging channel were studied as 2 phases of the downstream fish passage problem. In the first phase, an analytical method, augmented by experimental data, was developed for predicting discharge, length, velocity, etc., of the flow over the plate, given an initial flow rate and plate inclination and porosity. Experimental data covered a range in porosity from 0.2 to 0.33, two types of openings, and positive plate angles up to 15 deg. Results were obtained for the supercritical case only. In the second phase, the behavior of fish to flow conditions caused by a channel convergence was studied in hydraulic experiments. Wedges of about 7 deg placed with a relative spacing of 0.5 had shown positive guidance effects; those of about 3 deg showed none. A hydraulic index (acceleration, pressure or velocity change) for the large angle was about 7 times that for the smaller angle. For the 7 deg wedges, it is predicted that an increase in the relative spacing from 0.5 to 0.8 would eliminate any guidance effect. (Knapp-USGS)
W69-05667

09. MANPOWER, GRANTS AND FACILITIES

9A. Education (Extramural)

THE SOIL AND WATER CONSERVATIONIST OF TOMORROW,
Soil Conservation Service, Washington, D. C.; and Cornell Univ., Ithaca, N. Y.
Norman A. Berg, Paul J. Zwerman, and Gilbert Levine.
J Soil Water Conserv, Vol 23, No 6, pp 203-223, Nov-Dec 1968. 21 p, 7 photo, 19 ref.

Descriptors: *Conservation, *Soil conservation, *Water conservation, Soil science, Training, Water resources, Education, Economics, Plants, Management, Administration, Forest management, Bibliographies, Fish and wildlife, Forecasting.
Identifiers: Continuing education, Biological sciences, Managerial skills, Water resources management.

This collection of 7 papers describes the tasks and future educational and training needs facing a career conservationist in the next 2 decades. Change is occurring so fast in every field that on-th-job technical training will be needed continually. The 7 fields discussed are: (1) the soil and water conservationist, (2) the soil scientist, (3) the resource manager, (4) the resource economist, (5) the resource administrator, (6) the plant scientist, and (7) the fish and wildlife biologist. Tomorrow's conservationist will be required to take a broad view of the whole field. His formal education must provide a foundation in the natural and social sciences. Then he must take advantage of all available assistance to remain current in his field. (USBR)
W69-05842

9D. Grants, Contracts, and Research Act Allotments

ANNUAL REPORT FOR FISCAL YEAR 1968. WATER RESOURCES RESEARCH CENTER.
Massachusetts Univ., Amherst.

Massachusetts Univ Report to OWRR, 1968. 98 p.

Descriptors: *Massachusetts, *Research projects, Ponds, Animal wastes, Hydrology, Eutrophication, Pesticides, Cranberry bogs, Industrial wastes, Estuaries, Fisheries, Regional planning, Watersheds, Institutions and law.

This report describes activity on 16 projects conducted during the period July 1, 1967 to June 30, 1968. These projects cover research on lakes, rivers, groundwaters, and estuaries and coastal waters. The research involves the efforts of 26 faculty members and 43 students representing 14 University components. Areas under study include recreational use of small artificial ponds; watershed response to hydrologic variables; biological treatment and subsurface disposal of animal wastes; arrest of eutrophication processes in lakes by (1) removal of dissolved phosphates by special ion exchange resins, (2) control of benthic desposits, (3) intervention in microbial decomposition processes, and (4) nutrient removal by entrappment in vascular aquatic plants; evaluation of the fate and behavior of pesticides in soil, water and fish; recharge and groundwater management; manipulation of microbial communities in treatment of industrial waste; economic optimization of water uses in small watersheds, and analysis of evolving institutional processes. (Berger-Mass)
W69-05764

FOURTH ANNUAL REPORT, FISCAL YEAR 1967-1968.
Nevada Univ., Reno. Desert Research Inst.

Nevada Univ Center for Water Resources Research, Report to OWRR, September 1968. 81 p.

Descriptors: *Research facilities, *Training, *Education, *Water Resources Research Act, Arid lands, Nevada.

Due to the expanding population of the nation and of the state of Nevada, great pressure is being put on water supply. Therefore, the Center's research efforts, as shown in its 20 projects, act mainly as tools for the research workers' use in keeping pace with the demand for water of acceptable quality and quantity, as well as aiding the scientist in such areas as water resources planning and management, and the geochemical aspects of ground and surface waters. During the past year, 19 graduate and 24 undergraduate students were employed on research projects, which provided them with training in their major fields, and allowed for student association with senior scientists. Ten research associates engaged in projects of the Center are also teaching courses at the University of Nevada at Reno, thus exposing numerous students to new ideas as they are developed by the research staff. Members of the Center's staff are active in various local, state, federal, and international organizations. The recent establishment of a research facility in Las Vegas will enable the Center to meet the growing research responsibilities in Southern Nevada, with emphasis on the problems of water supply for urban areas in arid zones, of which the city of Las Vegas is a prime example. (Pincolini-Nev)
W69-05765

CONNECTICUT INSTITUTE OF WATER RESOURCES, ANNUAL REPORT 1967-68,
Connecticut Univ., Storrs.
W. C. Kennard.
Connecticut Institute of Water Resources, Unnumbered Report, 1968. 73 p (unpublished).

Descriptors: *Activities report, Research, *Annual report, Administration, Coordination, Publications.

Eighteen research projects were in effect covering the engineering, biological, physical, chemical agricultural and social sciences. Eight seminars were held around the theme 'Water Quality Control.' Five special seminars were given by University staff members. Nine journal articles, two Institute Reports, two M.S. and two Ph.D. dissertations were issued. Seven state financed graduate assistantships were awarded and two professorial appointments made, one in hydrology engineering and one in aquatic biology. The Institute director participated in planning regional cooperative research and cooperative symposia in the New England area.
W69-05773

10. SCIENTIFIC AND TECHNICAL INFORMATION

TRANSLATIONS OF FOREIGN LITERATURE ON HYDRAULICS.
American Society of Civil Engineers, New York. Committee on Hydromechanics.
For primary bibliographic entry see Field 08B.
W69-05655

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